



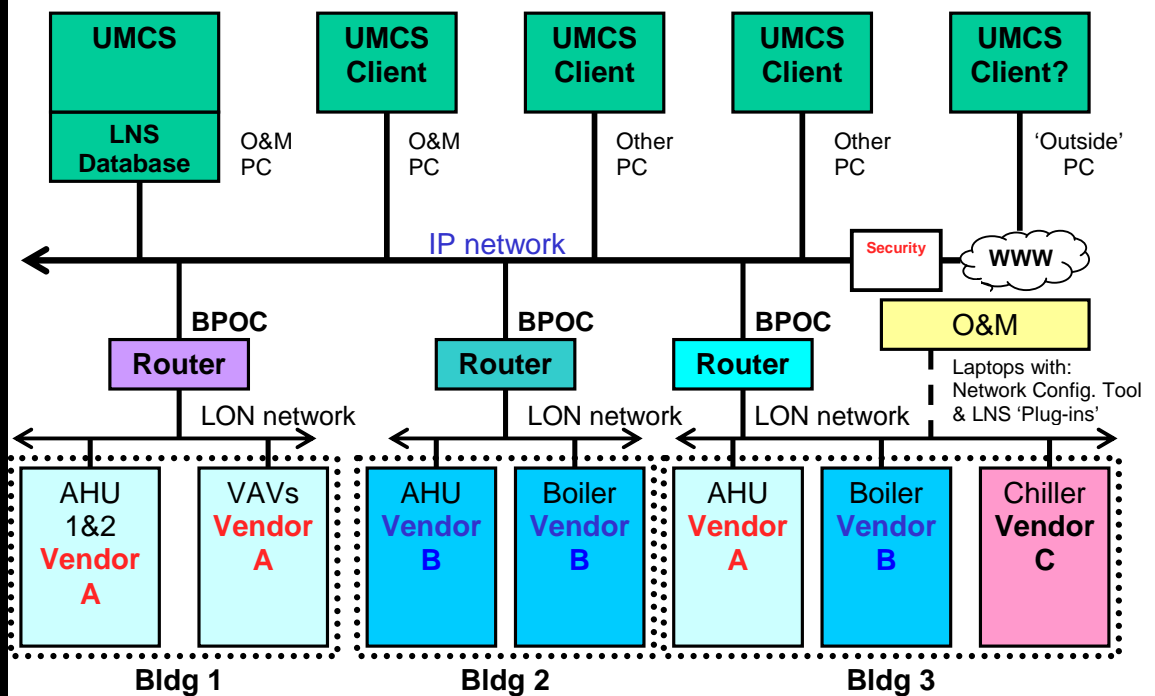
**US Army Corps
of Engineers®**
Engineer Research and
Development Center

IMCOM LONWORKS® Building Automation Systems Implementation Strategy

An Interim Report

David M. Schwenk, Joseph Bush, Lucie M. Hughes,
Stephen Briggs, and Will White

June 2007



BPOC=Building Point of Connection (UMCS to Building Control Network)

IMCOM LonWorks® BUILDING Automation Systems Implementation Strategy

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Final Report

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Abstract: Army Installations often expand their use of digital control systems for heating, ventilating, and air conditioning and other mechanical and electrical building systems on a building-by-building basis. The control systems are installed under separate contracts by different contractors resulting in intra-system incompatibilities. The implementation of multi-vendor Open Building Automation Systems (BASs) is meant to overcome such incompatibilities; however BASs can present their own technical and administrative (including contractual) challenges. This interim report defines a methodology for the development and execution of a basewide Open BAS implementation plan based on LONWORKS[®] technology and American National Standards Institute (ANSI) communications standard 709.1 where the BAS consists of a basewide Utility Monitoring and Control System (UMCS) that is interoperable with multi-vendor LONWORKS[®] direct digital control (DDC) systems.

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Preface

This study was conducted for the Installation Management Command (IMCOM) via Military Interdepartmental Purchase Request (MIPR) MIPR6MCERB1047. The technical monitor was Paul Volkman, Headquarters, Installation Management Command (HQ-IMCOM).

The work was managed and executed by the Energy Branch (CF-E) of the Facilities Division (CF), Construction Engineering Research Laboratory (CERL). The CERL principal investigator was David M. Schwenk. The U.S. Army Corps of Engineers agencies involved in the execution of this work include the Engineer Research Development Center Construction Engineering Research Laboratory, Savannah Directory of Expertise for HVAC Controls and Huntsville Engineering and Support Center Mandatory Center of Expertise for Utility Monitoring Control Systems. Personnel from Fort Hood, TX, Fort Bragg, NC, and other Army installations provided valuable input. Appreciation is owed for the ongoing interest, support, and seasoned recommendations and guidance provided by Bobby Lynn and Richard Strohl at the Fort Hood Energy Office, Jennifer McKenzie at the Fort Bragg Energy Office for her many close reviews, scrutiny, and insights, and Steve Dunning and other Fort Bragg Operations and Maintenance Division staff for their expertise and wisdom. The associated Technical Director was Martin J. Savoie, CEERD-CV-T. The Director of ERDC-CERL is Dr. Ilker R. Adiguzel.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Commander and Executive Director of ERDC is COL Richard B. Jenkins, and the Director of ERDC is Dr. James R. Houston.

1 Introduction

1.1 Background

Army Installations are expanding their use of direct digital control (DDC) systems for HVAC and other mechanical and electrical building systems, often on a building-by-building basis, in which the control systems are installed under separate contracts by different contractors resulting in incompatibilities between the separate systems. More significantly, these systems are often installed in the absence of the planning, preparation, training, and ground rules needed to obtain a functional, usable, expandable and—most notably—a supportable system.

The implementation of multi-vendor Open building automation systems (BASs) present both technical and administrative (including contractual) challenges. A BAS, within the context of this document, includes one or more building-level DDC systems interoperating with a supervisory utility monitoring and control system (UMCS) where the UMCS is used to monitor and manage the DDC systems. A longstanding goal of most Army installations is to implement a basewide BAS as opposed to multiple separate and independent BASs. A successful BAS is one that is functional, energy efficient, and cost effective.

More importantly, it must support the needs of the building occupants, operations and maintenance (O&M) staff, and management. Even though industry standards and specification guidance are available, there are many potential pitfalls. Unified facilities guide specifications (UFGSs) for BASs based on LONWORKS® technology and ANSI standard 709.1 communications protocol were released in FY04:

- DDC guide spec. UFGS 23 09 23 (previously UFGS 15951): Direct Digital Control for HVAC and Other Building Systems.
- UMCS guide spec. UFGS 25 10 10 (previously UFGS 13801): Utility Monitoring and Control System (UMCS)

These UFGSs were designed to address many open system pitfalls, but implementation challenges extend beyond the designer's ordinary realm of responsibility.

UFGS 23 09 23 (the DDC guide spec) specifies controls at the building level and UFGS 25 10 10 (the UMCS guide spec) specifies the supervisory

and basewide system. These criteria were developed to help with the implementation of Open, non-proprietary, and interoperable multi-vendor DDC systems that integrate with a UMCS. The UMCS is intended to be a single system that serves as a basewide interface to the multi-vendor building-level DDC systems. The intent of both the DDC and UMCS guide specs is to specify and procure an Open system. In practice, the UMCS user interface software will be procured from a single vendor, although the specification is written to ensure the system remains Open. Figure 1 illustrates a UMCS/DDC system where multiple building DDC systems have been integrated into a single UMCS that provides multiple operator workstations (“UMCS Client”). Figure 2 also shows the UMCS/DDC system and distinguishes between the UMCS and DDC elements specified by the two guide specifications.

An Open system, in short, is one where there is no future dependence on the original installing Contractor. For the purposes of procurement, this means that there is no sole source dependence on any Contractor for future system additions, upgrades, or modifications. An Open system helps to avoid proprietary sole source procurement in accordance with Government procurement rules. In practice, single-source procurement is valuable for smooth integration of building-level DDC systems into the UMCS, but single-source procurement can and should be avoided for the building-level DDC systems. Methods for procuring and expanding the UMCS are discussed in Section 2.4, “Identify Building Integration Approach” (p 18). Related BAS implementation guidance and information is available in ECB 2004-11, ECB 2005-17, ECB 2007-8, and ERDC/CERL Technical Reports TR-05-14 and TR-07-03.

1.2 Objective

The objective of this work was to define and document a methodology that will serve as a tool for the development and execution of a basewide Open BAS implementation plan based on LONWORKS® technology and ANSI communications standard 709.1, where the BAS consists of a basewide UMCS that is interoperable with multi-vendor LONWORKS® DDC systems.

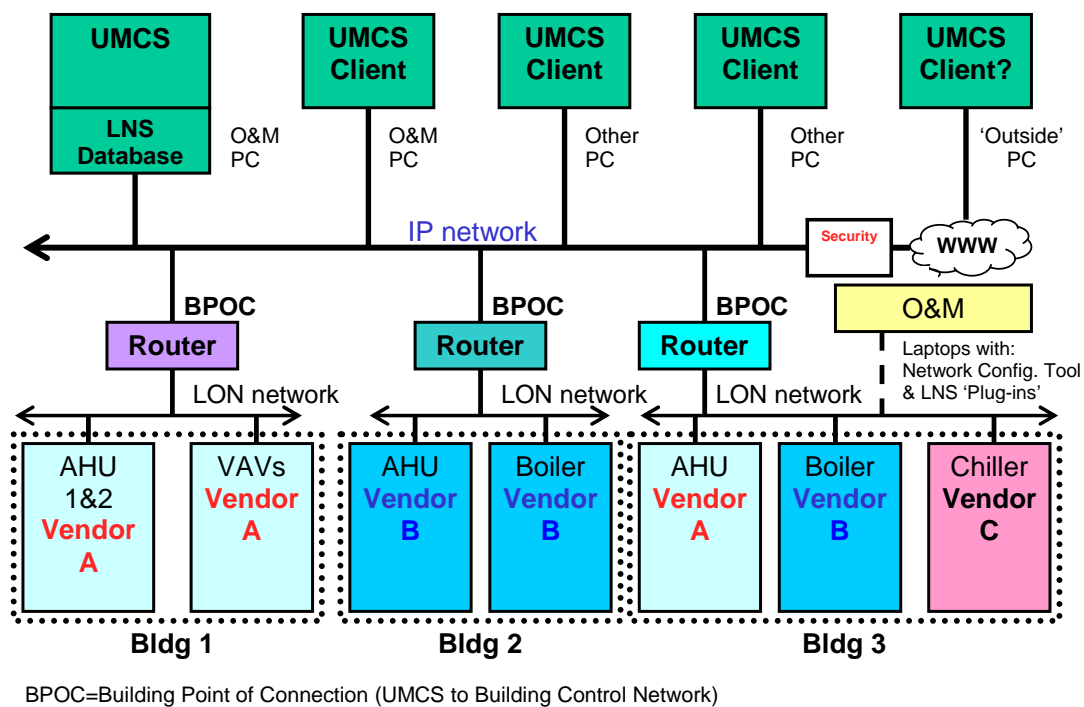


Figure 1. Basewide LONWORKS® BAS—including a UMCS and multiple-vendor DDC systems.

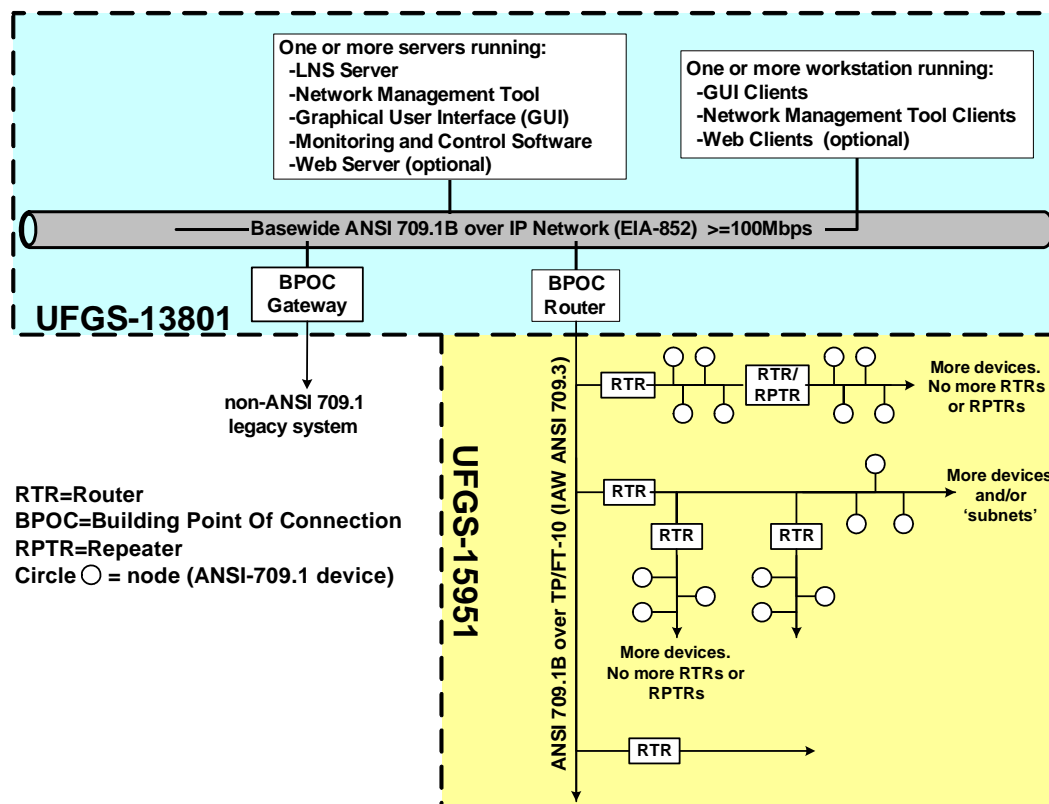


Figure 2. BAS comprised of UMCS and DDC systems.

1.3 Approach

The initial step of this project involved the creation and execution of an implementation plan for LONWORKS® building automation systems, documented in this report. In coordination with Huntsville Mandatory Center of Expertise for UMCS and Savannah District Directory of Expertise for HVAC Control Systems strategy described here is being implemented over the course of FY07 at five Army installations: Fort Bliss, Fort Bragg, Fort Hood, Fort Lee, and Fort Sill. A final report will be published in late FY07 to document lessons learned from field implementation at these installations. The appendixes to this report contain a variety of sample documents and templates (discussed in Chapter 2) prepared to aid installation planners in developing their planning and contracting documents and memoranda of understanding (MOU):

- Appendix A: Control Systems Assessment Statement of Work (p 33)
- Appendix B: DOIM FAQ (p 40)
- Appendix C: DOIM MOU (p 44)
- Appendix D: Installation Design Guide Draft Verbiage (p 45)
- Appendix E: UMCS and Systems Integrator Statement of Work (SOW) (p 49)
- Appendix F: UMCS and Systems Integrator Request for Proposal (RFP) (p 57)
- Appendix G: UMCS Source Selection Criteria and QV Checklist (p 60)
- Appendix H: Example Implementation Plan (p 62).

1.4 Scope

This document provides guidance on the creation of an installation-specific building automation system implementation plan with an emphasis on the definition, specification, and procurement of an Open basewide UMCS. Limited guidance on the implementation of building-level DDC systems is included. Specifically, building-level DDC guidance focuses on those requirements that deal with system interoperability with the UMCS, overall system functionality and maintainability. While this methodology is Army-specific, it may be generically suitable for use by other military and nonmilitary users. Similarly, while this methodology is specific to the implementation of LONWORKS based on the UFGSs, it may be generically suitable for a BAS using a different technology or protocol.

1.5 Mode of Technology Transfer

This report will be made accessible through the World Wide Web (WWW)
at URL: <http://www.cecer.army.mil>

2 BAS Implementation

Development and execution of a BAS Implementation Plan is the responsibility of the Installation. This development and execution can be accomplished through a combination of internal and external resources, where external resources may be necessary to obtain technical assistance and UMCS procurement assistance.

The following sequence of tasks and events describe the development of an integration plan and subsequent procurement of a basewide UMCS:

1. Assemble a BAS workgroup (Section 2.1, below)
2. Identify issues, goals, and obstacles (Section 2.2, p 9)
3. Identify approach to address obstacles (Section 2.3, p 12)
4. Develop statement(s) of work (SOW[s]) to obtain external technical assistance (Section 2.3.1, p 12)
5. Coordinate with Directorate of Information Management (DOIM) (Section 2.3.2, p 13)
6. Define/develop building acceptance methodology and checklists (Section 2.3.3, p 17)
7. Define training requirements (Section 2.3.4, p 17)
8. Develop IDG requirements and in-house LONWORKS® specs (Section 2.3.5, p 18)
9. Identify building integration approach (Section 2.4, p 18)
10. Develop UMCS and systems integrator SOW(s) (Section 2.4.5, p 24)
11. Document implementation plan (Section 2.5, p 25)
12. Execute UMCS procurement (Section 2.6, p 27).

This sequence is not fixed. The individual tasks/events along with the order might vary depending on the installation's situation and needs.

2.1 Assemble a BAS Workgroup

The Workgroup should minimally consist of:

- Energy Manager
- Chief of DPW O&M
- DPW Shop and/or work leader
- DPW mechanic(s)
- Plans and Programs
- DOIM and the Corps Area and/or Resident Engineer.

The Workgroup may also include the Corps District designer and external consultants such as Huntsville Center (HNC), Savannah District (SAS) and the Engineer Research Development Center Construction Engineering Research Laboratory (ERDC-CERL).

Not all members of the Workgroup need to be involved in the entire implementation plan development and execution process, but all members can be expected to contribute at various stages of plan development, and all members will benefit from the final plan. A statement of intent should be communicated to the Chief of DPW and the Garrison Commander through a memo, e-mail, or meeting since support of these individuals will be valuable to the successful development and implementation of the plan.

Generally, workgroup roles and responsibilities will be:

- *Energy Manager.* As the lead person responsible for energy conservation and ultimately responsible for operating and maintaining the BAS, at the installation, the Energy Manager will be primarily responsible for ensuring that the BAS functionality achieves the desired level of energy performance. This will require review of sequences of operation in the buildings, review of any installation-wide demand-limiting functionality, determination of metering requirements, and requests for installation of new hardware for energy efficiency. The Energy Manager should also ensure that any needed software or hardware tools required for performing O&M (e.g., laptops equipped with configuration software) is included with the procurement.
- *Chief of DPW O&M.* The Chief of O&M must ensure that the BAS can be supported by the DPW. This will require review of proposed sequences, control hardware, and front end functionality. Particular attention will be needed to ensure that the front-end user interface provides easy-to-use access to features the O&M staff deems essential. Finally, the Chief is responsible for ensuring that necessary training is provided and that O&M staff are available to participate in the training. DPW buy-in and ownership of the BAS is essential for a successful project.
- *DPW Shop Leader and Mechanics.* The advice and expertise of the individuals who will operate and maintain HVAC equipment operated by the BAS is critical. The maintenance staff ordinarily has a wealth of hands-on experience. They likely can also provide valuable input for defining training needs.

- *Plans and Programs.* In-house designs must be accomplished in accordance with the BAS Implementation Plan (described later) and resultant BAS requirements.
- *DOIM.* As the organization responsible for the basewide Internet technology local area network (IT LAN), and in particular responsible for security on this LAN, the DOIM's role in supporting the BAS installation and in ensuring that the BAS meets Army requirements cannot be overstated. Their participation in the working group is absolutely essential for a successful BAS installation. Modern BASs require a basewide Internet protocol (IP) network for operation. Coordination with the DOIM in obtaining this IP network is essential. While modern BASs have many similarities to IT systems, which may raise red flags with the DOIM, there are also important differences that can mitigate their concerns and a well-informed DOIM is the best insurance against major roadblocks later in the installation process. For example, while the BAS as specified in UFGS 23 09 23 and UFGS 25 10 10 does not rely on HTML, XML, Web Services, or http, (and in fact requires use of a different mechanism for communication) some BAS vendors may include products using these protocols in their submittals and coordination with the DOIM is needed to ensure that these products meet DOIM requirements or are rejected.
- *Corps Area and/or Resident Engineer.* The Corps Area and/or Resident Engineer is the party primarily responsible for system installation and commissioning, and for ensuring that the BAS meets the contract requirements and performs as specified. It is an unavoidable fact that Open System procurement and installation is more challenging than that of proprietary systems. Much of UFGS 23 09 23 and UFGS 25 10 10 is dedicated to communication issues/requirements; functionality that would just be "assumed to work" in a proprietary procurement. In addition, while UFGS 23 09 23 and UFGS 25 10 10 provide guide specifications, it is anticipated that designers will modify the specifications due to project-specific requirements. For these reasons, it is important that the Area and/or Resident Engineer be involved in this process.
- *External Consultants.* Most Corps design offices are overworked, and as previously noted, Open System procurement will be more challenging than proprietary procurement. For this reason, and particularly in the initial phases, it can be beneficial to obtain outside expert assistance, such as can be obtained from the Huntsville Mandatory Center of Expertise (MCX) for UMCS, Savannah Directory of Expertise (DX) for HVAC Control, or the Engineer Research Development Center (ERDC). Other private consultants may be equally valuable, however at

this time, few may have an in-depth familiarity with the guide specifications.

Finally, although not explicitly members of the Workgroup, the success of the BAS installation depends on several other individuals/organizations:

- *Chief of DPW.* The Chief of DPW can assist the Workgroup with advocacy across all DPW offices and well as between the DPW and DOIM, Job Order Contracts, P&P etc.
- *Garrison Commander.* A Garrison Commander who recognizes the value of a BAS that meets specifications can be a powerful advocate for getting a functioning BAS and their buy-in is critical.
- *Contracting Officer.* BAS Contracts can be challenging due to complex requirements and potentially burdensome contracting procedures such as the establishment of an indefinite delivery indefinite quantity (ID/IQ) contract for system integration/support services. The Workgroup should (and may already) recognize this challenge.
- *Building Tenants.* Occupants are often (understandably so) in a great hurry to move into a new/renovated building and often force beneficial occupancy before the BAS is complete. Occupants who understand the need for the BAS to function according to specification and can delay their move until the BAS is fully commissioned can become powerful champions of a successful BAS procurement.
- *Corps District Designer.* Designs must be accomplished in accordance with the installation's BAS Implementation Plan and requirements while working within the framework of UFGS 23 09 23 and UFGS 25 10 10. Membership in the Workgroup is optional, but communication and coordination with the Corps District is essential.

2.2 Identify Issues, Goals, and Obstacles

The Workgroup must address the current status of the installation's BAS(s). This includes creating lists of issues, goals and obstacles. These lists do not need to be rigorously detailed, but should be as complete as possible since they will be an important part of the final implementation plan for the BAS and are also important to help identify any "broken" policies or procedures that need to be addressed. Of equal importance is for the group to recognize (and not waste time on) problems that the BAS will not solve; the BAS is not a panacea and will not solve systemic procurement, commissioning, financial, or O&M issues.

2.2.1 Identify Issues

The first part of this step is to identify the main issues that exist with the current system or that the Workgroup feels might exist with future systems. This list of issues will be used to help identify the goals of the new BAS. Some issues commonly experienced by installations are:

- *Multiple BASs exist.* In some cases, installations have made the decision to maintain multiples BASs as a means to allow competitive procurement. In other cases, multiple BASs are a result of the procurement of incompatible systems. In either situation, it is generally more costly to maintain and expand multiple systems than a single system.
- *Many O&M laptops that are not used.* This often occurs when systems from many manufacturers are installed and these software tools are provided with limited training. Without training in, and frequent use of these tools, skills deteriorate and the installation's ability to troubleshoot and manage its systems is hampered.
- *Too many or not enough front-end computers.* There may be too many front-end computers when multiple BASs exist. Each system requires its own front-end interface and it takes several interfaces (software packages) to monitor the entire network. An installation may find it difficult to maintain training and skills on multiple front-ends, which often hampers its ability to effectively use the BAS systems. At the other extreme, the installation may have no front-end computer or other operator interface at all. These systems are extremely difficult to use and maintain since it is difficult to determine what they are doing.
- *Insufficient training.* The O&M staff is not adequately trained on the use and operation of the system.
- *Insufficient or superfluous BAS features.* The BAS includes features that are not needed and possibly confuse operators, or the BAS does not include features that are needed/desired by the installation (such as demand limiting).
- *Systems never worked.* Systems are accepted even though they are not functioning properly.
- *DPW not involved.* The DPW is not involved in the acceptance process for BASs so there is no sense of ownership by those that will have to maintain the system.
- *BASs are underused.* This usually occurs because the BASs are not properly configured to provide useful feedback to the operators.

2.2.2 Define Goals

Once the Workgroup has identified issues with the current BAS, it should define goals that will address these issues. The primary goal addressed by this implementation plan guidance is that of obtaining Open Systems. i.e., that the building and UMCS systems shall be Open implementations of LONWORKS® in accordance with the DDC and UMCS guide specs. This goal helps address several, but not all, of the issues identified above. Other goals the Workgroup may wish to consider are:

- *System Capabilities.* Identify the required capabilities of the system. For example, monitor the building-level systems and generate an alarm when something is wrong, provide scheduled on/off capability for all primary equipment, incorporate preventive maintenance features such as pump run time monitoring/logging.
- *Training and Support.* A successful UMCS will require a support structure and qualified staff. Identifying, establishing, and maintaining a balance of in-house and external support may be a challenge.
- *Client (Workstation) Type.* Some front end packages provide a web interface – sometimes as an option and sometimes as an integral part of the software. The Workgroup may wish to identify whether a web interface is desired and practical (e.g., whether there are DOIM requirements that prohibit it).

2.2.3 Rank Goals

After identifying the goals the Workgroup may choose to identify the relative importance of the goals. This list of prioritized goals can be used during the development of the source selection criteria for the UMCS and System Integrator SOW described in Section 2.4.5 (p 24).

2.2.4 Identify Obstacles

Once the goals for the system are identified the Workgroup should identify obstacles that might impact their ability to realize those goals. Some possible obstacles are:

- *Cooperation between DPW and DOIM.* These organizations will not necessarily agree on the best solution for the BAS. For example, DPW might want a web-based front end while DOIM might not want another web server on the network.
- *Resources.* Is there sufficient expertise on the DPW staff or otherwise available to enable the installation to operate and maintain the system?

- *Commitment of Management.* Management must make a long-term commitment to establishing a BAS that meets the Workgroup-established goals for these goals to be met.
- *Training Limitations.* To properly operate and maintain the system may require significant training. The amount of training time and funds available may impact the ability to train DPW staff to operate/maintain the system.
- *User Buy-in and Support.* The users (the DPW and maintenance staff) must buy-in to the system and support it for the Workgroup-established goals to be met.
- *Cost.* Systems meeting the implementation plan defined by the Workgroup may be more costly than other alternatives in the short term, but having a single coherent and working system will prove beneficial in the long term. If cost is the determining factor in awarding future construction, systems that are incompatible may be procured, e.g., if a contractor submits a “value engineering” proposal and it is awarded.

2.3 Identify Approach To Address Obstacles

Once the Workgroup has identified obstacles that may hamper the execution of the plan, it should identify an approach to addressing these obstacles. In general, the obstacles will fit one of three categories:

1. *Fixable.* These are obstacles that the Workgroup can eliminate such as policies that the Workgroup can change (or get someone to change) or management buy-in that the Workgroup can obtain.
2. *Addressable.* These are obstacles that the Workgroup cannot change; however, they can work around the obstacles in some fashion such as by obtaining exceptions from policy or by including specific requirements to be met by the system.
3. *Unavoidable.* These are obstacles that the Workgroup cannot change or work around and must avoid. Policies that do not offer exceptions or hard limits on funding are two examples.

The Workgroup should identify the appropriate actions to remove, modify or avoid “fixable” and “addressable” obstacles and begin to resolve these issues. “Unavoidable” obstacles should be carefully documented and a means to avoid them should be identified.

2.3.1 Develop SOW(s) To Obtain External Technical Assistance

The UMCS Workgroup should decide if external assistance is needed to proceed with development of the implementation plan and develop state-

ments of work (SOWs) to obtain this assistance. In particular, external assistance may be helpful in performing a site survey to document the current state of the installation's BAS and DDC systems and prioritize buildings for integration to the new UMCS (Figure 2).

Appendix A contains a sample SOW for this type of assistance. The Workgroup should feel free to add requirements to the SOW and/or to perform some of the work in-house. Should the Workgroup decide to pursue external assistance, it should consider contacting the local Corps District Office or the Huntsville Engineering and Support Center for possible contracting support.

2.3.2 Coordinate with DOIM

The BAS is dependent on an IP network for operation. This makes coordination with the installation Directorate of Information Management (DOIM) essential, for two main reasons:

1. On most installations any IP network including hardware/devices connected to the network must be approved by the DOIM.
2. There are many IT issues associated with the BAS, particularly with regards to security, for which the DOIM will be the resident expert, and will provide invaluable assistance.

The use of DOIM controlled networks and the integration of BAS networks must be pre-planned and coordinated to ensure multi-vendor system compatibility and to meet security requirements and certifications (such as DITSCAP and Networthiness).

In addition, DOIM can provide insight into the availability and benefits of alternative networking options that provide promise for cost effective systems interfacing and integration. Wireless networking options (such as WiFi or radio) can be of particular value when integrating remote sites or sites with other restricted access to the LAN.

The first step in coordinating with the DOIM is to explain (in terms relevant to the DOIM) what the BAS is:

1. The BAS will use two distinct networks:
 - a. Inside buildings, the local control network (as installed by the UFGS 23 09 23 contractor) will be a TP/FT-10 network (shown in Figure 2) using the ANSI 709.1 protocol. This is a local control net-

- work operating at 78 kbps, not an IP network and should therefore not be of concern to the DOIM.
- b. Outside the buildings, the BAS uses an IP network, ideally one based on fiber Ethernet, although any media supporting IP will work. This network may or may not be the same IP network as the DOIM maintained basewide LAN and is referred to as the UMCS Network (or the UMCS IP Network).
2. The BAS will have four distinct types of hardware:
 - a. Individual buildings will have specialized embedded control hardware. These devices are typically highly specialized and should not be considered “IT hardware.”
 - b. Each building will have a CEA-852 “router,” which tunnels ANSI 709.1 traffic from the building controllers (devices on the TF/FT-10 network) over the IP network. It is important to note that these are not IP routers; to the IP network they appear as end devices. This device is often referred to as the BPOC (Building Point Of Connection) shown in Figures 1 and 2.
 - c. A central Monitoring and Control (M&C) server, which is a standard PC running specific application software and will communicate with the CEA-852 routers to provide central management for the BAS. Note that the functionality of the M&C server may be spread among several PCs. The M&C server will also support OWS clients.
 - d. Operator Work Station (OWS) clients. These are standard PCs, which may or may not be running specific application software. They provide the user interface to the BAS for the system operators.
 3. Traffic on the basewide LAN will be of the following types:
 - a. Most of the traffic on the basewide LAN will be in the form of packets on UDP and TCP ports 1628 and 1629, which are registered with the Internet Assigned Numbers Authority (IANA) for “LonTalk® normal” and “LonTalk® urgent.” Most of this traffic will be from CEA-852 routers (the BPOCs) in buildings to the M&C server, although there will be some minor and infrequent traffic between CEA-852 routers.
 - b. Traffic between the M&C server and client OWSs. While the exact nature of this traffic is vendor-dependent, for many vendors the M&C server will act as a web server and the OWS clients will run a standard browser with a downloadable Java executable.
 - c. Occasional configuration traffic between the M&C server and the CEA-852 routers. The CEA-852 routers need to know the IP addresses of other CEA-852 routers. They can be manually configured

with static IP addresses, however, in most instances, there is a configuration server application that runs on the M&C server and periodically sends updated IP address information to the CEA-852 routers.

4. There are three possible UMCS IP network options as described/specified in UFGS 25 10 10:
 - a. *Shared LAN with the Basewide IP Network.* In this case, UMCS IP network is the same as the DOIM's basewide IT network and BAS traffic co-exists with other IT application traffic. It is suggested that the BAS be placed on a separate VLAN to improve security. However, the M&C server and OWSs might need to be exposed to the rest of the IT LAN, particularly if a large number of mobile (laptop) OWSs are used.
 - b. *Co-Located IT Hardware.* In this case, the UMCS IP Network is a physically separate network, but uses spare IT hardware. For example, the UMCS may run on spare network fibers and spare IT closet rack space. In this case, consideration needs to be given to whether there is any connection at the M&C server between the UMCS and the IT LAN, and if so, how to secure that connection.
 - c. *Completely Independent Network.* The UMCS has no common hardware or space with the IT LAN. Again, consideration needs to be given to whether there is any connection at the M&C server between the BAS and the IT LAN, and if so, how to secure that connection.

It is recommended that the installation pursue the first option, where the UMCS uses the basewide IT LAN. This will most likely be the lowest cost option since the contractor will not have to install significant IT hardware or cabling. In addition, there are many IT-specific issues – particularly security – that the DOIM is the logical resource to use on the installation. The only reasons to recommend against this option is if the DOIM places too many restrictions on access to the network, or equipment on the network; however this should not be an issue if UFGS 23 09 23 and UFGS 25 10 10 are strictly followed since they greatly limit the types of equipment that may be used in the buildings.

Some other issues to discuss with the DOIM are:

1. If the DOIM discourages connection to the basewide IT network, what are their policies regarding other independent networks? For some installations, other networks may be prohibited, in which case the UMCS must be on the basewide IT network.

2. What are their requirements for allowing a system to connect to the basewide network? Is DIACAP, Networthiness, or other certification required and if so how should the installation proceed? What restrictions would the DOIM place on the M&C server and client OWSs?
3. Access and interconnections (if any) between the UMCS network and the basewide LAN. While the BPOCs do not need a connection to the IT network, there are sound reasons for allowing the OWSs to be on the IT network (which implies that either they are on both the UMCS network and the IT network or more likely that the M&C server is on both LANs):
 - a. Use of the IT network for the OWSs allows tremendous flexibility for the location of the OWSs, particularly where the OWS client is a browser with a Java executable. In this case, almost any PC on the IT network becomes a potential OWS.
 - b. Use of IT resources from the OWS and/or M&C server, e.g., e-mail, M&C software updates, searching on-line documentation, etc.
4. Inbound access to the UMCS network from off-post. Although not specifically required by the guide specifications, many commercial M&C software packages have the capability of connecting with an OWS over the Internet. If coordinated and implemented with DOIM this may, for example, allow O&M staff to connect from home to perform troubleshooting. This raises obvious security concerns and should not be considered without consultation with the DOIM.
5. Use of wireless networking, Virtual Private Networks (VPNs), or other information technologies to access “hard-to-reach” points on the BAS, for example, a utility substation with metering that is not on the basewide LAN could conceivably be reached over the Internet with a dedicated VPN or wirelessly.
6. Any firewalls employed to restrict access on the UCMS network, or between the UCMS network and the basewide LAN. Even if the UCMS network is totally independent, the DOIM should be consulted to provide security information regarding the need for firewalls.

Appendix B contains a set of “FAQs” that may be useful in answering questions DOIM may have.

The WorkGroup and DOIM may choose to develop a memorandum of understanding (MOU) or similar document describing DOIM expectations and requirements. The MOU might include verbiage to be added to installation-specific UMCS specification, DDC specification, and other BAS-

related project specifications (such as in-house contracts). Appendix C includes considerations for the creation of a MOU with DOIM.

2.3.3 Define/Develop Acceptance Methodology and Checklists

An acceptance methodology is needed for construction QV staff and O&M staff. The appendixes to the guide specifications contain checklists that must be submitted by the Contractors quality control (QC) representative. These checklists can be used as a baseline for QV staff, but additional items addressing installation-specific concerns or commonly seen problems should be added by the Workgroup.

2.3.4 Define Training Requirements

The UMCS Workgroup should identify training needed to support the BAS.

O&M staff and system operators are targeted in the UMCS and DDC guide specs where the installing Contractor is required to provide training. Although the intent of the training requirements in the specifications is to achieve a degree of proficiency in system operation and maintenance, it should not be assumed that this training is sufficient. Individual installations and staff members may have specific training needs. The training requirements in these specifications can be edited to meet specific needs. Beyond this, it is likely that a degree of formal and specialized training will be needed to meet the complex demands of microprocessor-based controls including DDC hardware and software. Possible training options include:

1. *Vendor-Specific DDC Guide Spec Training.* Most construction contracts, specifically those that originate at the Corps District level, include contractor-provided training requirements. UMCS Workgroup and O&M staff should review and help edit the training requirements/specs during the design phase.
2. *Vendor-Specific UMCS Guide Spec Training.* The contractor-provided training on the UMCS front-end Monitoring and Control (M&C) software is extensive and specified in great detail. Still, additional training may be warranted depending on the extent that the system operator(s) will be involved with the operation and management of the UMCS. Individuals that will perform system integration functions should receive formal vendor training such as that offered at the vendor's formal training facility.
3. *PROSPECT Course.* "HVAC Control Systems: Design and Quality Verification." (Control No. 340) provides instruction on LONWORKS® con-

trol systems specific to the requirements in both the DDC and UMCS guide specs. Although designers and Quality Verification staff are targeted, O&M staff would also benefit from this course. The course schedule is available from the “USACE Learning Center” through URL: <http://pdsc.usace.army.mil>.

4. *Vendor Training.* Most BAS and DDC system manufacturers offer product specific training at the manufacturer’s formal training facility. This type of training can provide in-depth familiarity with specific products including software tools. Training on the Network Configuration Tool (NCT) and on the UMCS M&C software would be of value particularly in the case where the installation has selected a single-vendor NCT and M&C for its basewide BAS/UMCS. Note that both of these pieces of software are specified in the UMCS guide spec.

2.3.5 Develop IDG Requirements and In-House LONWORKS® Specs

The UMCS Workgroup should update the Installation Design Guide (IDG) to accommodate applicable elements of the Implementation Plan. Develop, coordinate, and distribute abbreviated LONWORKS® specs/requirements for use by in-house contracting elements such as Job Order Contract (JOC), Plans and Programs, etc. that can be appended to or used as part of any SOW used to specify BAS related work performed by in-house elements. Appendix D contains sample IDG requirements.

2.4 Identify Building Integration Approach

The methodology used to integrate building systems into the UMCS greatly impacts the procurement of the UMCS and should therefore be identified as early in the process as possible – and before the UMCS procurement if at all possible. Regardless of the approach, a final goal is to have a UMCS and SI approach in-place so that, as new building level DDC systems are competitively procured, these systems can be integrated with the basewide UMCS.

2.4.1 General System Integration Approaches

Ideally, the installation will have a specific individual responsible for the integration of all new buildings into the UMCS. This person – the system integrator (SI) – will be familiar with the system as well as the installations procedures for integration and would therefore be able to efficiently integrate new buildings. While it may be possible to get near this ideal through a long-term contract of some sort, it is not always feasible in

which case the integration may have to be performed on a case-by-case basis. In general, the integration approach will be one of the following:

- “In-House” System Integrator
- Long Term Contract
- Case-by-Case Integration (Using Separate Dedicated Contract)
- Case-by-Case (Using Combined Building Contract and Integration Services).

The following sections describe each of these approaches in detail.

2.4.1.1 “In-House” System Integrator

The installation hires or trains a SI. *This is the preferred/ideal approach.* By having the SI on staff, the installation benefits from maximum flexibility in the use of the SI. The installation does not have to issue task orders or a new contract to get systems integrated and can benefit from ongoing system maintenance. Contracting approaches that fit this category include:

- hiring or training a Government employee
- hiring a contractor through an existing services contract
- establishing a service contract
- obtaining services through another mechanism – such as ESPC.

A key aspect to this approach is that the SI services are provided at a fixed cost. The purchase of products needed to perform the integration is still dependent on the buildings that are integrated, but this amount is small. If this approach is used, it may be in the best interest of the installation to require that the building DDC system contractor provide the Building Point of Connection (Router) to remove this cost from the SI.

2.4.1.2 Long Term Contract

With this approach the installation establishes an Indefinite Delivery/Indefinite Quantity (ID/IQ) or similar contract with a SI. This approach allows the installation to obtain integration services from the same entity with the installation of each new building system, but generally will require issuing task orders for the integration, which may take additional time.

2.4.1.3 Case-by-Case Integration (Using Separate Dedicated Contract)

With this approach, whenever a new building is procured a separate specification for integration of the building to the UMCS is issued. By maintain-

ing this as a separate contract (rather than including it with the building DDC system specification) the competitive advantage that could be generated if the two tasks are combined (see below) is reduced. Since the original installer of the UMCS system will be most familiar with the system they may in practice have a small advantage in winning the integration contract, but this is a small task (dollar-wise) compared with the building DDC system. However, anyone familiar with the UMCS system software can perform this integration so proprietary procurement can be avoided. In this approach, tasks other than integration such as system upgrades and maintenance need to be accomplished under separate contract.

2.4.1.4 Case-by-Case (Using Combined Building Contract and Integration Services)

With this approach, the integration of the building into the UMCS is included in the building specification contract; a single contractor performs both tasks. This can give a competitive advantage to the original UMCS system installer/manufacture since they will generally be able to integrate the building more inexpensively than could the competition. While this is less of a problem with the “case-by-case integration using a separate dedicate contract” approach, it may become problematic when the contracts are combined because this advantage is not just on the integration, but on the building DDC system, which can be a large (i.e., costly) project. This is the least desirable approach and is discouraged.

2.4.1.5 Selection of a System Integration Approach

The system integration approach that the Workgroup decides to pursue will depend on many factors, including the contracting options and funding available to the installation. The “In-House SI” and “Long Term Contract” approaches may (but need not) be funded by the installation. In both cases, the agency issuing the contract to install a building system can likely set aside funds to pay for integration services. For example, if the Corps District awards a MILCON project for a building DDC system, and the installation has an ID/IQ contract in place for SI services, the District can MIPR funds to the installation to award an integration task on the ID/IQ. With the two “Case-by-Case” approaches, the agency issuing the contract to install the building system must both fund the integration and include integration requirements in the contract(s) awarded by the issuing agency. The workgroup should identify the approach as part of their basewide BAS planning process.

Due to the underlying network database standard specified in UFGS 25 10 10 and UFGS 23 09 23, should the need arise, the UMCS and Systems Integrator can be replaced without replacing the database or any of the building-level systems installed under UFGS 23 09 23. If the long-term contract integration option is pursued, on expiration of the long-term services contract the SI can be replaced, and the UMCS can potentially be retained depending on the technical skills/qualifications of the new SI. The capital investment in a replacement UMCS is small compared to the value of a System Integrations services Contract and to the investment in the building-level DDC systems to which the UMCS is interfaced.

2.4.2 Contracting Mechanisms

While evaluating these integration approaches the Workgroup should also consider the available contracting options. Some options are:

- Local Contracting Office
- Energy Saving Performance Contracting (ESPC)
- Corps District ID/IQ Contracts
- Centers of Expertise ID/IQ Contracts.

The following sections describe these approaches in detail.

2.4.2.1 Local Contracting Office

Depending on the workload and capabilities of the installation Contracting Directorate the local contracting office may be able to assist in establishing a long-term contract for integration services. A draft SOW/RFP (statement of work/request for proposal, see the example SOW/RFP contained in Appendixes E and F) will be useful in discussions with the local Contracting office. There is the advantage of working with people in the local area and developing relationships and conveying an understanding of the needs, but set asides and small business rules may restrict options to smaller companies with unknown skills. It is best to provide a very detailed SOW/RFP, defining all the specialized requirements and skill sets of the contractor. The Workgroup member(s) should be a part of the evaluation board to ensure the contractor selected is fully qualified and capable.

2.4.2.2 Energy Saving Performance Contracting (ESPC)

This is only one of a large set of performance type contracts that essentially provide the initial investment and get paid back from savings. It may be difficult to calculate the savings from building integration into a UMCS,

and to qualify for ESPC, a project must show energy savings. If considering using an ESPC for the UMCS installation, it may be best to add the integration services to the statement of work as well. Although ESPCs are widely thought to be the answer to under-funded installations, this funding mechanism does have some disadvantages. Most importantly, finance charges are paid throughout the life of the contract and the installation loses some control over the buildings included in the scope. Changes in building use or configuration that affect the planned savings may cause conflicts with the contract in terms of the shared financial savings. In some cases, the government has determined that it is advantageous to buy the contract out. If the installation can obtain integration and maintenance services for the UMCS and the integrated buildings and does not object to potentially losing a certain amount of direct control over the integrated building DDC systems this approach may work well.

2.4.2.3 Corps District ID/IQ Contracts

Some Corps Districts may have qualified vendors under an ID/IQ contract. They also may have contracting services that will issue the documentation to procure a system integrator for the installation. Each District is unique in this aspect.

2.4.2.4 Centers of Expertise ID/IQ Contracts

Most Corps of Engineers Centers of Expertise have a collection of vendors under contract with specialized skills that match up with and support the Center's mission. The Center of Expertise for Utility Monitoring and Control System (UMCS) is Huntsville's Engineering and Support Center. Huntsville has ID/IQ contracts with highly skilled and experienced UMCS vendors. Generally speaking, there are many advantages using the ID/IQ contracting vehicles: pre-selected vendors with focused skills, many years of experience, a long track record of success, no protests, great incentive to partner with and please the customer, and good leverage for problem resolution. The engineers at the Centers are familiar with the new LONWORKS® specifications and can provide design services, technical support during installation, review of submittals, and testing. This work for the installations is funded through fees from the customers. The Centers are reimbursed based on the level of effort requested.

2.4.3 System Integrator Considerations

It is important to consider the needs of the installation when evaluating potential system integration approaches and System Integrators. For example, the installation may be comfortable performing maintenance on the system and may only need the SI to perform actual integration or they may want the SI to perform maintenance as well. In general, the exact requirements placed on the SI will vary from place to place, but in general, some items to consider are:

1. *Training.* Integrators that work for/represent manufacturers of software for HVAC systems should have formal training on the software. Independent or third-party integrators that use other software (i.e., software not specifically made for HVAC systems, but for control systems in general such as industrial controls) should have training in the software they are using.
2. *Experience with LONWORKS®* (proven past performance including experience with UFGS 23 09 23 / UFGS 25 10 10 integration projects). This notably includes use of a LNS Network Configuration Tool and LNS plug-ins.
3. *Experience with other proprietary protocols and systems that pre-exist on site* should the Workgroup decide that the integration of these systems into the new UMCS is desired.
4. *Familiarity with DOIM and network security requirements.* Prior experience dealing with these requirements would be beneficial, but few integrators may have this experience.
5. *Knowledge of the building-level (UFGS 23 09 23) contractor's requirements* that will impact integration such as:
 - a. *Scheduling* – detailed familiarity with these requirements
 - b. *Alarm handling* – detailed familiarity with these requirements
 - c. *Point Schedules* – how to use them.

2.4.4 Acceptance Testing

Testing can be complex and detailed, and can require an experienced field technician or engineer. The UMCS system integrator can be a useful partner in working with UFGS 23 09 23 (or building-level) contractors, by performing submittal reviews, particularly in the case of the Points Schedule drawing and in the case of the control sequences such as alarm handling and scheduling that are highly dependent on ANSI 709.1 and the use of

SNVTs.* It is important to realize, though, that building-level system acceptance must be accomplished prior to any integration activities so as to avoid potential finger pointing in the event there are problems with the building-level system.

2.4.5 Develop UMCS and Systems Integrator SOW(s)

2.4.5.1 Overview

Based on the selected system integration approach, the Workgroup should develop one or more SOW(s) for the procurement of the UMCS and Systems Integrator (SI) support where the intent is to procure a single basewide UMCS and to procure SI services either via long term contract (preferred/ recommended) or on a case-by-case basis (where there are two options as previously described). Alternatively, SI services will be performed in-house, in which case a contract is likely not needed; however, arrangements must be made to define and formalize this SI mechanism.

2.4.5.2 UMCS/SI SOW

A sample draft UMCS and Systems Integration SOW is contained in Appendix E and related RFP language is in Appendix F. They should be used with caution and only as applicable to the selected integration approach. Guidance including notes and bracketed options for developing a project specific SOW is contained in the sample SOW.

2.4.5.3 UMCS Source Selection

A combined UMCS and SI procurement should be competitive and will ideally include a source selection process. A sample UMCS Source Selection and Quality Verification Checklist is contained in Appendix G. It is intended to be used for two purposes:

1. Evaluate a UMCS proposal (Source Selection)
2. Evaluate the installed UMCS (Quality Verification (QV) checklist).

The benchmark for evaluation is UFGS 25 10 10.

* Standard Network Variable Type. A standard format type used to define data for an ANSI 709.1 LONWORKS network

The QV checklist is heavily oriented towards items that impact the Openness of the system. Therefore, items that are important, but do not affect Openness are either de-emphasized or excluded entirely from the checklist. The checklist also contains items that are not part of UFGS 25 10 10, but are considered important to a functional and useful system. The checklist does not replace the Performance Verification Test (PVT) or commissioning items or requirements.

The Source Selection checklist contains:

- *Category* of the rating element from UFGS 25 10 10 referenced by UFGS 25 10 10 paragraph number. The UFGS 25 10 10 categories are un-modified (non-project specific).
- *Tier*. The checklist contains Tiered ratings. A Tier 1 element is considered to be so important that, if the system fails to meet the criteria, it results in the entire system being unacceptable. A Tier 2 element is also a requirement, but one that may be waived when there is justification for doing so. A Tier 3 element is considered important, but does not necessarily make the entire system unacceptable.
- *Two columns* indicating whether the element applies to Source Selection or to construction quality verification.

2.5 Document the Implementation Plan

The UMCS Workgroup should document the target basewide Building Automation System (BAS) and describe how to obtain it. The plan should include the results of the previous steps and guide the execution of the procurement and expansion of the UMCS. This plan should be considered a living document and should be updated periodically as lessons are learned from its execution. It should be as complete as possible and should define BAS goals, features, functions, requirements, needed support, integration approach, contracting methodology, and a path forward.

Once the implantation plan is documented it should be reviewed and coordinated with the Workgroup as well as any other individuals or offices/agencies who will be affected by it. (Appendix H contains a sample plan.) Some topics to include in the plan are:

1. *UMCS Workgroup*. Provide a list of members.
2. *Purpose/Problem*. Describe the current BAS situation including a description of the existing systems and problems that need to be addressed/overcome.

3. *Goals and Benefits.* Describe the goal(s) and benefits. Focus on the big picture functions and capabilities of the system.
4. *BAS Description/Characteristics.* The plan should describe characteristics, features and functions of the proposed BAS in more detail than that in the Goals/Benefits section. This might, for example, address/include:
 - a. The need for a computer operator workstation located in the Energy Manager's office, one in each Work Leader's office, one in each shop common area
 - b. The capability to perform scheduled Start/stop of air handling units from each operator workstation (OWS)
 - c. Other energy management functions such as monitoring and subsequent reports for specific systems or subsystems
 - d. The need for certain types of alarms and for alarms to be directed to specific shops/individuals
 - e. Building-level DDC system functions/features
 - f. Training and certain types of technical assistance.
5. *Support Structure.* The plan should define support requirements and a proposed support structure. This includes an internal support structure along with internal/external technical and contracting support. The support structure should include the designation of responsible parties for all aspects related to ongoing support of the BAS. It should also point out the need for coordination with specific in-house entities such as DOIM and Contracting office(s):
 - a. UMCS Workgroup
 - b. UMCS System Integrator (likely a Contractor, but possibly in-house staff)
 - c. System Administrator
 - d. DOIM Liaison
 - e. UMCS Workstation Manager (LNS database coordinator)
 - f. Laptop Manager (hardware/software management)
 - g. UMCS Operator(s)
 - h. DDC Specialists (hardware/software experts)
 - i. Building Acceptance POC
 - j. In-house contracting mechanisms/entities.

In regard to the in-house contracting mechanisms/entities, the plan should identify and list each in-house contracting mechanism that might be involved in the procurement of BAS elements (such as JOCs, Plans and Programs, etc.). Regardless of who procures them. Open, non-proprietary, interoperable systems must include at least minimal specifications to ensure compatibility of these systems

with the LONWORKS® UMCS. Coordination of these requirements with the in-house contracting entities is necessary to help ensure that all procured systems meet these requirements.

6. *Path Forward.* The plan should describe subsequent steps and expectations.

2.6 Execute UMCS Procurement

Once the implementation plan is complete, the Workgroup can proceed with the procurement of a UMCS as described in the plan.

3 Conclusion

This work has defined a methodology to serve as a tool for the development and execution of a basewide Open BAS implementation plan based on LONWORKS® technology and ANSI communications standard 709.1.

Should an installation decide to proceed with the implementation described in this report it is recommended that they contact the authors for additional guidance that may become available subsequent to the publishing of this report.

References

- Headquarters, U.S. Army Corps of Engineers (HQUSACE), Engineering and Construction Directorate of Civil Works (CECW) (17 September 2004). Engineering and Construction Bulletin (ECB) 2004-11. *Utility Monitoring & Control Systems (UMCS) and Direct Digital Control (DDC) Criteria Update*, Washington DC.
- Headquarters, U.S. Army Corps of Engineers (HQUSACE), Engineering and Construction Directorate of Civil Works (CECW-CE-D) (21 October 2005). ECB 2005-17. *LonWorks®, BACnet®, and Building Automation Systems Planning*, Washington DC.
- Headquarters, U.S. Army Corps of Engineers (HQUSACE), Engineering and Construction Directorate of Civil Works (CECW-CE) (18 April 2007). ECB 2007-8 *LONWORKS®, BACnet®, and Building Automation Systems Planning*, Washington DC.
- Schwenk, David M., Joseph Bush, and David M. Underwood (August 2005). ERDC/CERL TR-05-14, *Heating, Ventilating, and Air-Conditioning (HVAC) Control Systems Operations and Maintenance at Fort Bragg, NC*, Champaign, IL, accessible through URL: http://www.cecer.army.mil/techreports/ERDC-CERL_TR-05-14/ERDC-CERL_TR-05-14.pdf
- Schwenk, David M., Stephen J. Briggs, David M. Underwood, and Joseph Bush (February 2007). ERDC/CERL Technical Report 07-03, *Development of an Open Building Automation System Specification Based on ANSI/ASHRAE 135-2004 (BACnet® Communications Protocol): A Technical Assessment*, Champaign, IL, accessible through URL: http://www.cecer.army.mil/techreports/ERDC-CERL_TR-07-3/ERDC-CERL_TR-07-3.pdf
- Unified Facility Guide Specification (UFGS) 23 09 23 (previously designated UFGS-15951). (April 2006). *Direct Digital Control for HVAC and Other Local Building Systems*. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Washington, DC, accessible through URL: <http://www.wbdg.org/ccb/DOD/UFGS/UFGS%2023%2009%2023.pdf>
- UFGS 25 10 10. (previously designated UFGS-13801). (April 2006). *Utility Monitoring and Control System (UMCS)*. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Washington, DC, accessible through URL: <http://www.wbdg.org/ccb/DOD/UFGS/UFGS%2025%2010%2010.pdf>

Acronyms and Abbreviations

Term	Spellout
A/E	architect/engineer
AFB	Air Force Base
ANSI	American National Standards Institute
ASC	Application Specific Controller
BAS	Building Automation System
BPOC	Building Point Of Connection
BRAC	Base Realignment and Closure
CEERD	U.S. Army Corps of Engineers, Engineer Research and Development Center
CERL	Construction Engineering Research Laboratory
CO	Contracting Officer
COE	Chief of Engineers
COL	Colonel
DDC	Direct Digital Control
DHCP	Dynamic Host Configuration Protocol
DIACAP	Department of Defense Information Assurance Certification and Accreditation Process
DITSCAP	DoD Information Technology Security Certification and Accreditation Process
DOIM	Directorate of Information Management
DPW	Directorate of Public Works
DX	Directory of Expertise
ECIP	Energy Conservation Investment Program
EIA	Electronic Industries Alliance
EMCS	Energy Management Control System
ERDC	Engineer Research and Development Center
ERDC-CERL	Engineer Research and Development Center, Construction Engineering Research Laboratory
ESPC	Energy Savings Performance Contract
FAQ	Frequently Asked Questions (FAQs)
FMD	Facilities Maintenance Division
GPPC	General Purpose Programmable Controller (GPPC)
GUI	graphical user interface
HNC	Huntsville Center
HQ	headquarters
HQ-IMCOM	Headquarters, Installation Management Command
HTML	hypertext markup language
HVAC	heating, ventilating, and air conditioning
I/O	input/output
IANA	Internet Assigned Numbers Authority

Term	Spellout
IATO	Interim Authority To Operate (IATO)
ID/IQ	indefinite delivery indefinite quantity
IDC	Indefinite Delivery Contract
IDG	Installation Design Guide
IL	Illinois
IM	instant messaging
IP	Internet protocol
IT	Information Technology
JCI	Johnson Controls, Inc.
JOC	Job Order Contract
LAN	Local Area Network
LCS	LONWORKS® Control Station
LDP	local display panel
LNS	LONWORKS® Network Services
MCX	Mandatory Center of Expertise
MILCON	Military Construction
MIPR	Military Interdepartmental Purchase Request
MOU	memorandum of understanding
MS	Microsoft®
NC	North Carolina
NCT	Network Configuration Tool
NTP	Notice To Proceed
OI	operator interface
OMA	Operations and Maintenance, Army
OMD	Operations Maintenance Division
OSI	Open Systems Interconnection
OWS	Operator WorkStation
PC	personal computer
PDA	personal digital assistant
PDF	Portable Document Format
POC	point of contact
PROSPECT	Proponent Sponsored Engineer Corps Training
PVT	Performance Verification Test
QC	quality control
QV	Quality Verification
RFP	request for proposal
SAS	Savannah District
SI	Système Internationale (the “Metric System”)
SNMP	Simple Network Management Protocol
SNVT	Standard Network Variable Type
SOW	statement of work
TCP	Transmission Control Protocol

Term	Spellout
TP/FT	twisted-pair/free topology
TR	Technical Report
UDP	User Datagram Protocol
UESC	Utility Energy Services Contract
UFGS	Unified Facilities Guide Specification
UMCS	Utility Monitoring and Control System
URL	Universal Resource Locator
USACE	U.S. Army Corps of Engineers
VLAN	Virtual Local Area Network
VPN	Virtual Private Network
WWW	World Wide Web
XIF	eXternal Interface File
XML	Extensible Markup Language

Appendix A: Control Systems Assessment

Statement of Work

The following is a sample statement of work (contract) (SOW) used for the implementation of the guidelines in this report at several installations. For use at a single installation, this SOW must be tailored to refer to installation specific requirements and to refer to only one installation.

STATEMENT OF WORK ARCHITECT-ENGINEER SERVICES FOR IMCOM BUILDING AUTOMATION SYSTEM IMPLEMENTATION PLANS FOR FORT BRAGG, NORTH CAROLINA, FORT LEE, VIRGINIA, FORT BLISS, TEXAS, AND FORT HOOD TEXAS

1. REFERENCE. Indefinite Delivery Contract (IDC). This task order will be issued under IDC W912HN-05-D-0017.

2. OVERVIEW. This work is in association with a joint effort among ERDC-CERL, Huntsville Engineering and Support Center, and Savannah District funded by IMCOM to define a methodology for the development of a basewide open Building Automation System (BAS) plan based on LONWORKS® technology and ANSI standard 709.1 as specified in UFGS 25 10 10 and 23 09 23 where the BAS consists of a basewide UMCS that is interoperable with multi-vendor LONWORKS® DDC systems.

3. DESCRIPTION OF WORK. This SOW covers all services to perform site visits to four installations: Fort Bragg, North Carolina; Fort Bliss, Texas; Fort Lee, Virginia; and Fort Hood Texas; and to prepare resulting reports based on the site visits. This will include pre-site visit planning and coordination with all team members, LONWORKS® site assessment, on-site coordination assistance/participation, development of site-specific Implementation Plan verbiage, tables, and data, in an Assessment Report. The objective is for the architect/engineer (A/E) to perform a site-specific assessment of LONWORKS® BASs and BAS components to determine if and to what extent the installations' BASs are in compliance with the requirements defined in UFGS 25 10 10 and UFGS 23 09 23. The A/E shall pro-

vide recommendations on how the installation can proceed to obtain a basewide UMCS in accordance with UFGS 25 10 10 and 23 09 23 including an assessment of local contractors' capability to support UFGS 25 10 10 and 23 09 23 where the goal is to assist each installation prepare for and achieve state of the art, maintainable, operable, and cost effective basewide BAS. For the purposes of this SOW, a BAS is defined as a group of DDC systems interconnected via a communications network (such as IP) with a front-end/UMCS and a standalone DDC system is defined as one that is not connected to a front-end/UMCS.

4. REQUIRED A/E SERVICES. The A/E shall perform the services indicated in the Statement of Work. These services will be provided in three distinct phases:

- Pre-site visit planning
- Pre-site visit telephone calls to site staff
- Site visits
- Assessment Reports.

4.1. Pre-site visit activities.

a. Participate in a conference call with SAS, HNC, ERDC-CERL and POC(s) from each site to review the technical requirements of this SOW. The purpose will be to go over the thrust of the effort, to identify all initial points of contact, and to solidify the details of the site visit and the reports. Anticipated level of effort: 0.5 days.

For each installation, the following shall be accomplished:

b. Contact the Government supplied site POC to schedule a site assessment visit with appropriate personnel to assist in performing the tasks described in the SOW. Personnel may include; the Energy Manager, DPW Chief of O&M Division, DPW Chief, O&M Production Control, DPW Shop Foreman, DPW Work Leader, Engineering Services Branch Chief, and DPW HVAC/Controls staff, DPW A-76 Contractor (IAP) HVAC/Controls staff. Notify the Government of scheduled site visit(s). For Fort Hood related work the A/E need only speak and meet with Mr. Dick Strohl. Anticipated level of effort: 0.5 days per site.

c. Obtain as much advance information listed in exhibit A as is possible via telephone calls in advance of site visits. For Fort Hood, the A/E need not execute the items in Exhibit A. Anticipated level of effort: 3 days per site.

4.2. Site visits. For each the installation, the following shall be accomplished:

Perform site visits to identify and quantify the installation's BASs. The intent is to get a working sense from a long term planning perspective of the state of the installation's BASs and to obtain lessons learned. The information in Exhibit A shall be obtained. For Fort Hood, the A/E need only update the report: SITE SURVEY AND DATA COLLECTION UTILITY MONITORING AND CONTROL SYSTEM (UMCS) MASTER PLAN FORT HOOD, TEXAS including; Chapter 1. General Description, Chapter 2.2 Review of UMCS Currently Installed at Fort Hood, and Chapter 3. Buildings For Future UMCS Master Plan. The Fort Hood work shall include new LONWORKS® control system additions to the existing SITE SURVEY. Anticipated level of effort: 5 days per site.

4.3. Assessment Report.

a. For each installation, after the site visit, the A/E shall provide a finished Assessment Report documenting the site assessment and providing all information described above including names of individuals that the A/E spoke and met with. The assessment shall include the recommendations on how the installation could proceed to obtain a basewide UMCS in accordance with UFGS 25 10 10 and 23 09 23, including the assessment of local contractors' capability to support UFGS 25 10 10 and 23 09 23. In the case of Fort Hood, the A/E need only update the SITE SURVEY report. Anticipated level of effort: 2 days per site.

b. For each installation, the A/E shall schedule a conference call to present and discuss the Assessment Report to ERDC-CERL, Savannah District, and Huntsville Engineering and Support Center. Both parties will discuss the issues and, if necessary, attempt to resolve unsettled issues that may arise. Anticipated level of effort: 0.5 days per site.

4.4. Notes and Discussions. The A/E shall take notes and prepare minutes for all meetings and conferences attended during the project. Minutes shall be signed by the project manager and furnished to the Savannah District project engineer within 7 calendar days after the meeting/conference for concurrence and distribution. The A/E shall provide a written record of all significant discussions and telephone conversations that the firm's representatives participate in, on matters relative to the project. Records will

be provided within 7 calendar days of the conversations. Anticipated level of effort: included in above tasks.

5. SUBMITTALS AND PERFORMANCE SCHEDULE.

5.1 All deliverables will be provided electronically to the Savannah District project engineer. Deliverables include:

- Notes and minutes of all conferences – included in Assessment Report.
- Record of significant discussions and conversations – included in Assessment Report.
- Assessment Report and update of the Fort Hood SITE SURVEY report – within 7 calendar days of completion of the site visit.

5.2. Performance Periods and Submission Schedules. The performance periods and submission schedules for each item are indicated below. All activities must be completed by 30 July 2007.

Item	Due after NTP (calendar days)
a. Notice to Proceed	—
b. Conference call (A/E, CERL, SAS, HNC)	8
c. Site visit 1 complete	As mutually agreed
d. Submit Site 1 Assessment Report	14 days after item c.
e. Site 1 conference call (A/E, CERL, SAS, HNC)	7 days after item d.
f. Site visit 2 complete	As mutually agreed
g. Submit Site 2 Assessment Report	14 days after item f.
h. Site 2 conference call	7 days after item g.
i. Site visit 3 complete	As mutually agreed
j. Submit Site 3 Assessment	14 days after item i.
k. 3 conference call	7 days after item j.

6. AUTHORIZED CHANGES. The A/E shall accept instructions only from the Contracting Officer or his duly appointed representative. Coordination of routine technical matters with Corps of Engineers personnel will be accomplished through the project engineer, Lucie Hughes, CESAS-EN-EP. Direct requests from other agencies should be forwarded to the Project Engineer for consideration.

7. EXHIBITS.

A. Installation Assessment Information

EXHIBIT A

Installation Assessment Information

- a. **BAS System List:** List of LONWORKS® and non- LONWORKS® BASs, both existing and under construction. Where available provide diagrams in PDF or other electronic format
- b. **Total number of buildings connected to a BAS,** as a total number and as an estimated percentage of the installation.
- c. **BAS System details:** For each BAS on the BAS System List provide the following information:
 - **Operator interface (OI) system name and manufacturer.** Provide version number if available and applicable particularly where it might be of interest as part of a basewide systems integration plan. For example, if the OI is widely used or applied or is LNS compatible. Number of buildings connected to the BAS, as a total number and as an estimated percentage of the installation or other indication of the system size at contractor's discretion
 - **Functions and Utilization.** Provide a summary of functions that the BASs perform (alarms, scheduling, trending, etc.) particularly those functions of interest and value to the DPW. Provide an indication of the degree and type of utilization of the BASs by the DPW and others.
 - **Unusual types of equipment monitored or controlled** such as lighting systems, energy-monitoring-only systems, access control systems, etc. where the intent is obtain an awareness of any special needs or requirements that the installation might have beyond ordinary HVAC control.
 - **For each building connected to the BAS provide:**
 - **Building numbers, building group, or area.** The intent, within time and resource constraints, is to obtain as much detail as is reasonably available.
 - **Product (manufacturer) name for DDC controls** contained within/under the BASs. The intent is to obtain insight into the variety and types of DDC hardware at the installation. As part of this, of interest is the relative quantities of ASCs versus General Purpose Programmable Controllers (GPPCs). Interaction with a knowledgeable individual in one of the DPW shops can facilitate this effort.
 - **Installing controls contractor name.** (Also see related requirement later in the Exhibit).
 - **For LONWORKS® BASs,** provide an assessment of each ones compliance with UFGS 25 10 10 and answer the following questions:
 - **What media type was used?**
 - **Are UFGS 25 10 10 compliant CEA 709.1 to IP (CEA 852) routers used?**

- Are gateways (such as NAE's, JACE's, or other similar products) used? If yes, list gateways including product name.
 - Are alarms implemented in accordance with UFGS 25 10 10 and in compatible accordance with UFGS 23 09 23?
 - Is (occupancy) scheduling accomplished in compatible accordance with UFGS 23 09 23?
 - Were licensed copies of an NCT submitted? How many copies? Where are they?
- b. What DDC and BAS preference(s) does the installation have such as a particular brand or type of control (such as ASC versus GPPC). Any/all insights are useful.
- c. Description of how the various BASs are integrated such as; Are there multiple front-ends, are any on the basewide LAN, are there gateways at the building level, are different manufacturers systems integrated together, are there BASs that contain control networks at the building level, but are not interfaced to an OWS, are any BASs configured for dial-up-only access, etc.
- d. Summary of BASs and buildings that are based on LONWORKS® technology.
- e. Summary of and UFGS 25 10 10 compatible front-ends that have a software gateway to the existing BAS. (e.g., a JCI MEA with an NIE to an existing Metasys BAS)
- f. For LONWORKS® building-level systems (that may or may not be part of a BAS, i.e., these can be “standalone” systems), identify compliance with UFGS 23 09 23 for a representative sample of not less than three UFGS 23 09 23 systems, in each case installed by different contractor. Provide the following:
 - Assessment of submittals:
 - Were Points Schedule drawing(s) submitted? Obtain and submit copies of the Points Schedules. Provide an opinion as to whether the Points Schedules meet the intent and requirements of UFGS 23 09 23.
 - Was an LNS database submitted?
 - Were XIF files submitted?
 - Were LNS plug-ins submitted? Are LNS plug-ins available (from the manufacturer) for the installed devices?
 - If programmable controllers were used was the programming software submitted? Was the application program submitted?
 - Are the building systems in accordance with the UFGS 23 09 23 LONWORKS® requirements? Provide an overall answer to this question as well as specific answers to the following:
 - Was the “scheduling sequence” accomplished in accordance with UFGS 23 09 23
 - Are alarms implemented in accordance with UFGS 23 09 23?
 - Was a critical alarm handler provided?
 - Is there a System Scheduler?

- Are all devices connected to a TP/FT-10 building control network?
- What O&M tools (such as an NCT) were provided or are otherwise available? Do the tools meet UFGS 23 09 23 and 25 10 10 requirements? For TP/FT-10 networks are there network interface jacks available as specified and are there dongles available for workstation (laptop) connection? Are there software packages or tools other than an NCT?
- Perform a network analysis of one building's (or more if time permits) TP/FT-10 network and compare the results to the requirements of UFGS 23 09 23 and the Points Schedule.
- g. Identify and list local vendors/contractors (name, phone, e-mail, website) who do work at the installation.
 - If available, provide an indication of the extent/magnitude of their work experience at the installation such as how many jobs (such as many, few, one), job size (numerous systems, one or two buildings), and approximately how long have they been doing work at the installation.
 - Provide an assessment of their capability to install and support LONWORKS® in accordance with UFGS 23 09 23 and 25 10 10, particularly LNS.
 - What UMCS/DDC brands/product lines does the contractor support? Are the products LNS compatible?
 - How much experience does each Contractor appear to have with UFGS 23 09 23/25 10 10 systems?
 - Assess Contractor's potential/capabilities to implement UFGS 23 09 23 scheduling and alarm sequences.
 - What Contractor preferences does the installation have? Are any contractors on a non-compliance or "problem" list? If yes, indicate why if the reason is known and publicly available non-sensitive information.

Appendix B: DOIM FAQ

1. What is ANSI 709.1?

The “Control Network Protocol Specification” ANSI 709.1 is an ANSI standard communications protocol (including Open Systems Interconnection [OSI] layers 1 through 6, originally developed by the Echelon Corporation (Echelon refers to it as “LonTalk®”) and widely used for data communication between devices designed for monitoring and control of building automation systems.

2. What bandwidth requirement and traffic profile does it have?

The average bandwidth requirements are very low, with occasional (still quite modest) peaks. Almost all traffic will be between a single building point of connection (BPOC) and a master front end monitoring and control (M&C) computer, and it is meaningful to discuss network bandwidth requirements at two points:

- Inside the building, traffic is on a dedicated CSMA/CD network (not part of the IP network) operating at 78 kbps. This inherently limits the bandwidth on the IP network side.
- The greatest bandwidth requirement will be at the central M&C server, where the average requirement can be estimated based on two factors:
 - *Communications from the buildings.* While this traffic increases with the number of buildings each building contributes only a small amount to the bandwidth usage.
 - *Communication between the software server and clients.* The bandwidth usage will depend on the software used and the number of workstations. This communication is more bandwidth intensive than communications with the building systems, but depends on the number of OWSs, not the number of buildings.

Note that, by the very nature of building automation systems, most data packets will be very small; the data portion of the IP packet will generally be on the order of 64 bytes or less.

3. Does it use standard protocols, including TCP, IP, DHCP, and SNMP?

Yes. ANSI 709.1 is a standard protocol including OSI layers 1 through 6; however it can run on an IP network via a tunneling protocol, CEA-852. As far as the IP network is concerned, the basewide network will consist of these 852 “routers,” one (or two if redundant servers are installed) central monitoring and control (M&C) computers, and additional computers acting as clients to the central M&C computer. These devices will all use TCP/IP and DHCP.

4. Will there be unmanaged web servers on the network?

No. The BAS specified under UFGS 23 09 23 and UFGS 25 10 10 does not use HTML, XML, Web Services, or http to communicate among devices. Depending on the vendor selected under the UMCS contract according to the UMCS specification, the front-end M&C server may use a web server to support operator workstations. However, this will be a single (or perhaps a small number of co-located) machines that can be located in a secure area. If this is a concern, the DOIM representative on the BAS Working Group should help to define additional requirements and/or restrictions on the UMCS Contractor to ensure that either any web servers will meet DOIM requirements or that proposals using web servers be excluded from consideration.

5. What other protocols are used?

The normal sharing of data packets between BPOCs located at the buildings and the M&C server is tunneled on TCP/UDP ports 1628 and 1629.

6. Does it use broadcasts?

The CEA-852 routers do not use broadcasts—they tunnel ANSI 709 packets as point-to-point packets to other CEA-852 routers. The M&C server and client computers will run a standard operating system that may use broadcasts (but this is not specific to the control system and DOIM is used to dealing with such operating systems).

7. What are the IT connectivity requirements?

Each building will require a single network drop and (preferably) static IP address for each of CEA-852 router. For large buildings, it is possible that two or more CEA-852 routers will be used, in which case more network

drops and IP addresses will be required. Point-to-point links will be implemented between these 852 routers and also between these routers and a single (duplicate if redundant hardware is installed) front-end monitoring and control (M&C) server computer. Because this network configuration is fairly static, a VLAN should be constructed to isolate all the 852 routers and the M&C server from the rest of the IP network. However, there will be other client computers connected to the front end M&C server; these machines may be on the same VLAN as the 852 routers, or they may be on a more general basewide IT VLAN, in which case the M&C server would need to exist on both VLANs.

8. What existing IT infrastructure components beyond the network itself will be affected?

None. There may be additional issues if the DOIM and DPW determine that the DOIM should manage the M&C server.

9. What new network infrastructure components are required?

Buildings will need a connection to the basewide IP backbone. For buildings where this already exists, no new components are required beyond a network drop and an IP address.

10. How are the network components secured?

Ideally, with DOIM permission, the CEA-852 routers will be secured in the same network closets as the standard DOIM IP hardware and isolated on a dedicated VLAN. The M&C server and other client workstations will be secured using whatever means the DOIM uses for standard office PCs. (Note that the use/capabilities of these computers could actually be more restricted than for a standard office computer. For example, these machines should not require access to the Internet so it would be possible to deny them this access.) No specific security requirements are necessary for the low-level control hardware inside the buildings.

11. Can the network components be infected by a virus?

No. The network components in the building are low-level embedded processors, running very specific control algorithms on non-Windows operating systems and are not subject to attack by viruses, trojans, or worms designed to attack general purpose PCs and network hardware. Similarly, the 852 routers are designed for a specific task – the routing of ANSI 709

packets. The fact that they are not general purpose computers and are not servers makes them extremely secure against outside attack.

12. Can network components be hijacked to infiltrate a network?

No. The low-level controllers are not on the IP network. If the DOIM wishes, the building control network can be placed on a protected VLAN and not exposed to outside attack. Any possible attack against them presupposes that the basewide IP network has already been compromised. Even in the unlikely event of a successful attack, the 852 router does not support common clients – its usefulness as a platform to attack the rest of the network is practically non-existent. Finally, the compromised hardware is still on an isolated VLAN. The M&C server PC and OWSs will be protected as any standard PCs and DOIM input is required to determine the best approach to protecting these machines.

13. Will it require any non-standard ports be opened?

No. The communication between 852 routers and each other and the M&C server uses UDP and TCP ports 1628 and 1629, which are registered with IANA for “LonTalk normal” and “LonTalk urgent.”

Appendix C: DOIM MOU

Considerations for the DOIM MOU:

- The DOIM POC is: _____.
- The BAS Workgroup POC is: _____
- DOIM will review any contract/procurement package that includes IP equipment
- The Workgroup / DPW will notify DOIM of any unscheduled IP related work
- Server(s) and their location will be pre-approved by DOIM
- Un-managed servers are not permitted
- BPOCs shall be located in DOIM communications closets or other DOIM approved spaces
- BPOCs shall be tested for [xyz]
- DOIM will provide static IP addresses
- Server and workstation Operating System software shall be [Windows XP]
- Office automation system software shall be [MS Office Professional Version x or later]
- E-mail software shall be []
- No instant messaging (IM) software shall be permitted on any computer
- Workstation “administrator” requirements include:
- etc.

Appendix D: Installation Design Guide Draft Verbiage

Short Version

Digital controls shall be based on LONWORKS® Technology designed and installed in accordance with UFGS 23 09 23, which is based on ANSI/CEA 709, Energy Information Administration (EIA)-852, and the LonMark Interoperability Guidelines in support of base-wide multi-vendor interoperability. Gateways (protocol translators) shall be avoided, but may be provided on an exception basis only as specified in UFGS 23 09 23. BAS technologies that lead to proprietary sole-source procurement for system expansions are not acceptable. (An exception to UFGS 23 09 23 is that general purpose programmable controllers [GPPC] shall not be used. Instead, only application specific controllers [ASC] are permitted. Where an application specific controller is deemed unsuitable by the contractor due to the complexity of the application, the contractor shall obtain Contracting Officer [or CO Representative] approval for use of a programmable controller.) Contractor's are encouraged to propose an alternate (less complex) control sequence that will result in the use of an application specific controller (ASC) in lieu of a programmable controller. Control system installation shall be coordinated through the DPW with the Fort [] UMCS System Integrator culminating, as specified in UFGS 23 09 23, in the submission of an LNS database for the project and an LNS plug-in for each installed application specific [and general purpose programmable] controller/device.

Detailed Version: (Courtesy of Fort Hood, TX)

LONWORKS® is the overall open systems communication technology for building automation systems. LONWORKS® is further described by "LonMark International," an industry organization established to support LONWORKS® technology (<http://www.lonmark.org>). The term may include reference to any/all of the: protocol, network management, and interoperability guidelines where the technology is based on the Energy Information Administration (ANSI/EIA) 709.1B protocol and employs interoperable devices along with the capability to openly manage these devices (via multiple vendors) using a network configuration (or service) tool.

All new and renovation control projects, where the controls are to be interfaced to the Utility Monitoring Control System (UMCS), shall be coordinated with the Fort Hood UMCS “System Integrator” through the DPW Energy Branch. The UMCS interface design shall be in accordance with Unified Facility Guide Specification 25 10 10 (Utility Monitoring Control System – formerly UFGS 13801). In cases where 25 10 10 may not be used, the project design must minimally include a “Points Schedule” that lists:

- domain/subnet numbers (obtained from the UMCS System Integrator) for the installed controls;
- all points/values to be displayed/monitored at the UMCS
- points that must have override capability (such as setpoints, equipment on/off settings)
- alarm conditions/setpoints (if applicable) along with names, e-mail addresses, and/or pager numbers of individuals to be contacted (by the UMCS) in the event of an alarm.

Unified Facility Guide Specification 23 09 23 (Direct Digital Control for HVAC and other Local Building Systems – formerly UFGS 15951) addresses specifies system requirements for Direct Digital Controls (DDC) using LONWORKS® that are applicable to Fort Hood. Fundamental 23 09 23 requirements, plus Fort Hood specific requirements (as indicated by the wording “At Fort Hood ...”) include:

1. The control system shall be an open implementation of LONWORKS® technology using ANSI/EIA 709.1 as the communications protocol and using LonMark Standard Network Variable Types as defined in LonMark SNVT Master List for communication over the network;
2. All DDC hardware shall be connected to a TP/FT-10 ANSI/EIA 709.3 control network and communicate over the control network via ANSI/EIA 709.1B exclusively.
3. LONWORKS® Network Services (LNS) shall be used for all network management including addressing and binding of network variables. A copy of the LNS database shall be submitted to the project site as specified.
4. The hardware shall perform the control sequences as specified and shown to provide control of the equipment as specified and shown.
5. LonMark certified control hardware (devices) shall be used when a device that meets the control sequence is available. Certified devices are listed at <http://www.lonmark.org/products/>. At Fort Hood, if minor deviations from the specified control sequence would permit the use of a Certified device (when one is otherwise not available), the contractor is encouraged to submit the Certified device along with a description of

- the deviation(s). Non-certified devices are permissible as long as they otherwise adhere to the specified LONWORKS® requirements.
6. At Fort Hood, application specific control (ASC) hardware is preferred over programmable controllers. If minor deviations from the specified control sequence would permit use of an ASC (when a programmable controller would otherwise be required), the contractor is encouraged to submit the ASC along with a description of the deviation(s).
 7. LNS plug-ins shall be provided with all control hardware. Devices without LNS plug-ins shall be used on an exception basis only and require Government approval. A partial list of control hardware with LNS plug-ins is available through URL:
<http://www.echelon.com/products/networktools/plugin/default.asp>
 8. At Fort Hood, packaged HVAC units/equipment shall include factory installed LONWORKS® control hardware when/where this control option is available. Fort Hood's prefers that the contractor select packaged HVAC units that provide this control option.
 9. Control sequence logic shall reside in DDC hardware in the building. The building control network shall not be dependent on connection to a Utility Monitoring and Control System (UMCS) for performance of control sequences in this specification. The hardware shall, to the greatest extent practical, perform the sequences without reliance on the building network.
 10. The hardware shall be installed such that individual control equipment can be replaced by similar control equipment from other equipment manufactures with no loss of system functionality.
 11. All necessary documentation, configuration information, configuration tools, programs, drivers, and other software shall be licensed to and otherwise remain with the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor,
 12. The Contractor shall provide sufficient documentation and data, including rights to documentation and data, such that the Government or their agents can execute work to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor.
 13. Hardware shall be installed and configured such that the government or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the Contractor.
 14. Control hardware shall be installed and configured to provide all input and output Standard Network Variables (SNVTs) as shown and as needed to meet the requirements of this specification.

15. All DDC devices installed under this specification shall communicate via EIA 709.1B. The control system shall be installed such that a SNVT output from any node on the network can be bound to any other node in the domain.

Appendix E: UMCS and Systems Integrator Statement of Work (SOW)

Note: This SOW refers to the UMCS specification as *Section 25 10 10*. This specification was formerly *Section 13801*. If the 13801 nomenclature is still used on the specification for this project edit this SOW accordingly.

Introduction

Fort [____] DPW currently has and continues to receive multiple brands of Direct Digital Control (DDC) systems that are not integrated into a UMCS. The individual multi-vendor DDC systems are often provided with laptops, PCs, and software tools resulting in overwhelming complexity due to the ordinary complexity of DDC technology compounded by multiple tools from multiple manufacturers. The end result in the absence of a UMCS is potentially a very useful mix of building automation systems that are currently of limited effectiveness to routine DPW operations.

Major Tasks:

Note: Not all of these requirements and related tasks may be applicable. It is expected that if Task 1 is included that Task 2 and/or Task 3 will be as well. If a UMCS already exists, however, Task 1 may not be included in which case the tasks and references to them should be edited accordingly.

The major requirements of this SOW are:

1. Provide a Utility Monitoring and Control System (UMCS) in accordance with the attached Section 25 10 10 and this SOW.
2. Integrate [____] building DDC systems into the UMCS in accordance with the attached Section 25 10 10 and this SOW.
3. Provide integration support in the form of UMCS management, technical support and future building DDC system integration as specified in this SOW for a period of [____] years.

Task Descriptions:

Task 1: Provide a Utility Monitoring and Control System

Provide a Utility Monitoring and Control System consisting of system hardware, software and related infrastructure as specified in Section 25 10 10 and this SOW. Unless otherwise specified requirements in this SOW are in addition to those in Section 25 10 10.

Networking Requirements

Note: DOIM Requirements are only applicable when the UMCS is sharing the basewide LAN (i.e., DOIM is responsible for the network that the UMCS operates over). In the rare instances that a dedicated DDC/UMCS network is used these requirements should be deleted.

The Fort [____] Directorate of Information Management has strict requirements for systems on the basewide LAN. The following requirements must be adhered to:

[INSERT DOIM REQUIREMENTS HERE (including computer operating system requirements)]

Drawing/Submittal Requirements:

Note: Table E1 (at the end of this appendix) must be edited and included.

In addition to the drawing requirements in Section 25 10 10 the Computer Software Products to be installed on each computer shall be shown or otherwise clearly listed in the UMCS Contractor Design and As Built drawings.

Factory Test Requirements:

In addition to the Factory Test requirements in Section 25 10 10 demonstrate the capability of the UMCS to interoperate with a DDC system that is complaint with Section 23 09 23 [that was not previously connected to the existing UMCS] by specifically demonstrating the following:

1. *M&C Software scheduling.* Demonstrate the capability of the Monitoring and Control software to provide network variables of the type SNVT_Occupancy to a device in a building DDC system as follows:
 - a. Scheduled occupancy SNVT: Change the value of the SNVT according to a time schedule and demonstrate the capability of the software to transmit the SNVT at no less than once every 45 minutes.
 - b. Override occupancy SNVT: Change the value of the SNVT according to a manual override from a graphics page.
2. *M&C Software alarm handling and alarm routing.* Demonstrate the capability of the software to accept network variables of types SNVT_Alarm and SNVT_Alarm_2 and to route these alarms as specified in Section 25 10 10.
 - a. *M&C Software Trending.* Demonstrating the setup and implementation of a trend using real-time SNVT data obtained from a building DDC system.

Note: If this SOW does not include the installation of a UMCS (task 1) include a detailed description of the current UMCS here. This will be critical to allowing the contractor to determine their ability to meet the requirements in Task 2 and/or Task 3. Examples of the type of information to provide include:

- Monitoring and control software type – version, manufacturer etc
- BPOC hardware currently used
- Sample graphic screens from M&C software.

[The Fort ____ UMCS consists of...]

Task 2: Integration of Building DDC Systems

Note: The intent of this task is to perform immediate integration of existing systems. This may not be desired and if so delete this task.

A fair amount of detail may be required for the Contractor to provide integration pricing. Some systems may be more integration-ready than others. Describe the buildings/systems to be integrated: Are they LONWORKS® systems or not, what manufacturer (brand) are the existing devices, are the devices on a TP/FT-10 network, is an LNS database available/provided, are Point Schedule drawings available/provided, etc.

Integrate the following buildings/systems into the UMCS, including database management, graphical display creation and setup of supervisory control functions (scheduling, trending, alarm handling etc) in accordance with Section 25 10 10 and this SOW. Unless otherwise specified, requirements in this SOW are in addition to those in Section 25 10 10. The buildings to be integrated under this contract are:

[_____]

Task 3 Integration Support

Note: If system integration is anticipated for systems (besides those specified by 23 09 23) such as legacy/existing non- LONWORKS® systems, edit the requirement below by listing or otherwise describing these non-23 09 23 systems.

Task 3a: Prepare Systems Integration Methodology

Develop and submit a proposed Systems Integration Methodology consistent with the open system requirements in this SOW and section 25 10 10 and the related applicable section 23 09 23 requirements. Subsequent to review by the Government address Government comments and resubmit the methodology.

The methodology shall describe the technical approach for accomplishment of the integration of building DDC systems installed in accordance with Section 23 09 23. The description shall include all elements contained in this SOW including, but not limited, to:

Note: Provide POC info. Describe each person/offices role.

1. *Government Coordination.* Describe the procedure for coordinating with the Corps of Engineers District, Corps of Engineers Area/Resident Office, DPW, and DOIM as applicable. Include, at a minimum, the following Government personnel:
 - [DPW, Energy Manager: name, phone, e-mail. Role/responsibility]
 - [DPW, Chief of O&M: name, phone, e-mail. Role/Responsibility]
 - [DPW, Shop Foreman: name, phone, e-mail. Role/Responsibility]

- [DPW, Shop Work Leader: name, phone, e-mail. Role/Responsibility]
 - [DOIM: name, phone, e-mail. Role/Responsibility]
 - [District Office Engineer: name, phone, e-mail. Role/Responsibility]
 - [Area Office Engineer: name, phone, e-mail. Role/Responsibility]
- a. *LNS Database*. Describe the procedure for managing the UMCS LNS database(s) including the preferred approach to the integration of building DDC. For example, should building contractors work directly from the basewide LNS database? Will building databases be merged to create a single basewide database or maintained as separate databases? What guidelines will be used to determine when databases are or are not merged? In general, the creation, use, and maintenance of multiple databases is understood to be an acceptable practice as long as they all reside on a single server.
 - b. *Connectivity*. Describe the procedure for providing the BPOC and obtaining the IP connection. Include any inspections or testing you will perform to verify that the interface between the UMCS and the third-party building-level system can be accomplished.
 - c. *Programming and Configuration*. Describe the procedure for programming, configuring and otherwise setting up hardware and software to accomplish Monitoring and Control software functionality as specified in Section 25 10 10.

Task 3b: Long-Term Integration Services

Provide system integration services and support for [____] years. These services include the following tasks and shall be performed under [an ID/IQ contract where task orders will be issued for the integration of new building DDC systems]:

1. *Building-level systems compatibility review*. Review submittals from building DDC system contractors or installers and assess the readiness of the system for integration into the UMCS. The Government will provide the following submittals (as specified and described in Section 23 09 23) for review:
 - Points Schedule drawings
 - Riser diagram showing building control network
 - LNS Database for building DDC system
 - XIF files and LNS Plug-ins for devices used in building DDC system.

Provide review comments to the Government within [____] days from receipt of documents.

- a. *Building DDC system integration.* Perform integration of building DDC systems installed in accordance with Section 23 09 23 as specified in Task 2 of this SOW and in accordance with the Government approved Systems Integration Methodology.
- b. *Integration Services Log.* Create and maintain an Integration Services Log to document activities and actions that impact the UMCS or building-level systems. The log shall be kept current and may include, but not be limited to:
 - The Government approved Integration Methodology.
 - Riser Diagram Drawing showing the details and location of servers, workstations, printers, and other UMCS-related equipment.
 - Points Schedule for each integrated building/system including; device addressing, Standard Network Variable Types (SNVTs) (points) displayed by the M&C Software, SNVTs that can be overridden by the M&C Software, SNVT alarm points, SNVT trend points, and Alarm Routing (in coordination with the Alarm Routing Schedule).
 - Alarm Routing Schedule drawings that identify and assign priorities, pager telephone numbers, e-mail addresses, and alarms to be printed.
 - Demand Limit schedule drawing including system name, load shed priority, and SNVT needed for shut-down or setpoint reset.
 - LNS database: Activities such as modification, merging, creation, backup, file renaming, transfer amongst computers, etc.
 - Control System Schematics for each building-level control system (the as-built drawings submitted by the building DDC system contractor).
- c. *UMCS Hardware and Software Maintenance and Support.* Operating System and IP network use, maintenance, and management shall be accomplished in cooperation with and in accordance with DOIM requirements.
 - UMCS Workstation Access: Manage the overall operation and maintenance of the UMCS LNS Server and the M&C software workstation and its clients. UMCS network, system, and software password access and level of access shall be at the discretion of the DPW. The DPW Chief of O&M, or his/her designated Government employee(s), shall have full and highest level administrative access to password control.
 - UMCS Server and Workstation maintenance: Perform routine repair and maintenance of all UMCS Server and Client computers, including all desktops and laptops (i.e., "All" UMCS

workstations). The Contractor shall upgrade/update UMCS M&C and Network Configuration Tool (NCT) software as recommended by the manufacturer at the discretion of the DPW Chief of O&M or his/her designated Government employee(s) in consultation with the Contractor.

- d. *UMCS Workstation Management.* Manage all UMCS-related O&M workstation hardware and software including the M&C software, NCT software, LNS Plug-ins, and dongles (Table E1 lists example components). Laptop management activities shall be conducted in a manner that minimizes interference with O&M maintenance staff access to workstations. Workstation Management includes the following requirements:

- In coordination with the Chief of O&M or his/her designated government employee, develop and maintain a record of all O&M workstations. The record shall include a listing of all HVAC control related software installed on each laptop including the software version number/date and the HVAC control software package logins/passwords. Label each laptop and laptop case with an identifier.
- Define requirements for new/additional laptop workstations and NCT licenses as needed (beyond those that are existing or initially provided) so that the Government may coordinate these requirements with procurement requests or inclusion in construction project specifications.
- Furnishing LNS-plug-ins for each new building-level construction project where the building-level contractor submitted these plug-ins and the Contractor served as the System Integrator. The plug-ins shall be furnished with informational guidance on how to load/install the plug-ins on the individual workstations.
- Updating / merging the LNS database from each new building-level construction project where the building-level contractor submitted the database and the Contractor served as the System Integrator.

Table E1. UMCS workstation management chart.

Hardware Component	M&C	NCT	OAS	VPS	Location
Server	X	X	X	X	[Need this info for all components]
Workstation client - desktop	X		X	X	
Workstation client - desktop	X		X	X	
Workstation client - desktop	X		X	X	
Workstation client – laptop	X		X	X	
Workstation – (O&M) laptop	X	X	X	X	
Workstation – (O&M) laptop	X	X	X		
Workstation – (O&M) laptop	X	X	X		
Workstation – (O&M) laptop	X	X	X		
Workstation – (O&M) laptop	X	X	X		
Alarm Printer					
Alarm Printer					
Alarm Printer					
Laser Printer					
Color Printer					
BPOC Router (see “System Integration Services”)					
BPOC Gateway (see “System Integration Services”)					
Fiber Optic Patch Panel					
Fiber Optic Media Converter					
Ethernet Switch					
IP Router					
Abbreviations: M&C: Monitoring and Control Software NCT: Network Configuration Tool Software OAS: Office Automation Software VPS: Virus Protection Software					

Appendix F: UMCS and Systems Integrator Request for Proposal (RFP)

Note: This is a draft RFP.

Introduction

Provide a proposal package in accordance with this RFP for the work described by the attached UMCS and Systems Integrator Statement of Work (SOW)

Contractor Requirements and Qualification Statement

The proposal shall describe the Contractor's knowledge and experience in each of the following areas. Where minimum contractor qualifications are specified, these are minimum qualifications the contractor must have to be awarded a contract under this RFP:

- IP Network experience of team members, particularly in working with DOIM and with DITSCAP/DIACAP and Networthiness requirements/certification. As a minimum, the Contractor team must have IP network experience (and previous experience with DITSCAP and Networthiness.)
- Previous experience in the installation and service/support of LONWORKS® based systems. As a minimum requirement the Contractor must have a minimum of three (3) years experience in the installation and service of LONWORKS® based systems using LONWORKS® Network Services (LNS). The Contractor shall submit a list of no fewer than three (3) similar projects executed by the Contractor that included LONWORKS® and LNS-based BAS as specified herein. These projects must be on-line and functional such that they can be observed with the system in full operation.
- Staff shall be formally trained. As a minimum the contractor shall demonstrate training and training-related experience integrating interoperable systems, Monitoring and Control software programming and configuration, Network Configuration Tool programming and configuration. The Contractor shall have training or training related ex-

- perience with third party LONWORKS® control system hardware and software.
- The Contractor shall have a service facility. As a minimum, Contractor staff shall include qualified service personnel capable of providing routine and emergency maintenance on networked control systems and system components.
 - Staff shall have experience developing and delivering on-site training.

Product Information

Include the following information for the products to be used on this project:

- For the Monitoring and Control Software and Network Configuration Tool, provide:
 - A data sheet with basic information on product.
 - Screen shots of typical screens encountered during use of the product.
 - A technical contact prepared to describe product features and capabilities. This contact should be a member of the organization or company that produces the software.
 - Copies of the software license agreements including pricing/cost information.
- For the Building Point of Connection (BPOC) hardware, provide:
 - A data sheet of product model and version to be used.
 - A technical contact prepared to describe product features and capabilities. This contact should be a member of the organization or company that manufactures the hardware.

Integration Support Pricing

Note: Include this if the SOW includes long-term integration services (Task 3).
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Provide pricing for Task 3 of the SOW. Pricing may be arranged by building-level system type (where the Contractor lists and shows these in the Price Structure), number of points to be integrated, UMCS functions performed (trend, alarm, etc. according to these UMCS functions as specified in UFGS 25 10 10) (where the Contractor lists/shows these in the Price Structure), animated graphic display of system versus a simple listing of the points, etc. ID/IQ costs shall include, but not be limited to; Engineering services, M&C software configuration/programming/setup, IP network

installation (where required), BPOC, and other Systems Integration-related hardware and software. All costs associated with System Integration Services shall be provided in the ID/IQ Pricing.

Appendix G: UMCS Source Selection Criteria and QV Checklist

Table F1. UMCS source selection criteria and QV checklist.

Category	UFGS 25 10 10 paragraph	Tier	Applies to:	
			Source Selection	Quality Verification
		1,2, or 3		
Products				
Front End Hardware				
Workstation	2.3.3	2	X	X
Printer	2.3.4	2	X	X
Alarm Printer	2.3.4.1	2	X	X
Laser Printer	2.3.4.2	2	X	X
Color Printer	2.3.4.3	2	X	X
Server	2.3.2	2	X	X
UPS	2.5	2	X	X
Front End Software				
General	2.4.1-5		X	X
Network Configuration Tool	2.4.5	1		
M&C Capability	2.4.6			
System Units as specified	1.3.3	3		X
Graphical User Interface	1.3.1.c	2		
Passwords	2.4.6.1	2	X	X
Protocol Drivers	2.4.6.2	2	X	X
System Graphic Displays	2.4.6.3	2		X
Scheduling	2.4.6.4	1	X	X
Alarming	2.4.6.5	1	X	X
Trending	2.4.6.6	2	X	X
Power Demand Limiting	2.4.6.7	2	X	X
PDL with real time pricing	2.4.6.8	2	X	X
Programming Language	2.4.6.9	2	X	X
Report Generation		2	X	X
Submittals				
Shop Drawings	1.4	2		X
Product Data	1.4	2		X
Design Data	1.4	2		X

Category	UFGS 25 10 10 paragraph	Tier	Applies to:	
			Source Selection	Quality Verification
Test Reports	1.4	2		X
O&M Data	1.4	2		X
Records, Logs, and Progress Reports	1.8.7	2		X
Preventative Maintenance Work Plan	1.8.8.1	2		X
Existing Conditions Survey	3.1	3		X
Network Bandwidth and Usage Calcs	3.2.1	2		
Design Drawings	3.2.2	1		
As-Built Drawings	3.2.3	1		X
Communications				
IP Network Detail	1.3.1.a	3	X	X
SNVTS only		1	X	X
Network speed, type, protocols	1.9	2	X	X
Data comm equipment	2.1.3	3	X	X
Network Hardware	2.2	1	X	X
Router Hardware	2.2.2.1	1	X	X
Gateway	2.2.2.2	2	X	X
Execution				
Wire and Cable installed correctly		2		
Computer Hardware Installed as shown		2		
Software installed	3.4.4.2	1		
Network Hardware		1		
Building Level Controls Integrated	3.5	1		X
Services				
User Interface				
Navigation				
Documentation of Compliance				

Tiered ratings: A Tier 1 element is considered to be so important that if the system fails to meet the criteria it results in the entire system being unacceptable. A Tier 2 element is a requirement, however it is a requirement that may be waived when there is justification for doing so. A Tier 3 element is considered important, but does not necessarily make the entire system unacceptable.

Appendix H: Example Implementation Plan

IMPLEMENTATION PLAN For [FORT BRAGG] BUILDING AUTOMATION SYSTEM (draft 4/2/07)

Workgroup Members

- Steve Dunning, FMD Work Leader
- Ashley Gore, FMD Work Leader
- Russ Hayes, DPW Mechanical Engineer
- Derrick McRae, Mechanical Engineer
- Jennifer McKenzie, Energy Manager
- Tom Patrick, FMD Work Leader
- David Taylor
- Jose Troche (DOIM)
- Vic Walker, Operations Maintenance Division (OMD) Operations Officer
- Wilhelmina Pierce (COE)

Purpose

The purpose of this document is to describe [Fort Bragg's] basewide Building Automation System (BAS) including the goals, features, and benefits of the BAS along with a strategy for successful implementation, use of, and support of the BAS.

Note: This document makes reference to Unified Facility Guide Specifications UFGS-13801 and 15951, which have been assigned new numbers; UFGS 25 10 10 and 23 09 23, respectively.

Problem

[Fort Bragg] has two basic problems;

1. Multiple brands of Direct Digital Control (DDC) systems that are not integrated into a common single-interface user-friendly system. There are currently three "enterprise" systems with no overall plan to inte-

grate all systems into an installation wide system or connect the new "smart" buildings.

- a. Honeywell Inc. has an onsite presence at the Energy Information Center. Through an ESPC Honeywell uses their EBI platform, which is interfaced to 165 building-level control systems (installed by Honeywell) including approximately 50,000 points and approximately 280 energy meters (elec, gas, water). Honeywell has installed nine EBI-related servers. Four of these (CoGen plant, JSOC, Main, and Energy Center) are networked to the servers at the Energy Information Center, the other five are not. There are 14 workstations located at the Central plants, Work Order Center, and the Energy Information Center). Currently the system software license includes 12 simultaneous users per server with up to 40 licensed users possible (per server). there is no contractual arrangement to obtain system integration services to integrate new (Honeywell or 3rd party) LONWORKS® building-level systems to the EBI front-end. The EBI system includes proprietary elements including 88 Tridium JACE and 96 Honeywell C-bus controllers where each of these is at the "building level." The JACE and C-bus devices do not accommodate a logically flat TP/FT-10 network connection (where the logically flat network is currently the preferred open systems approach). Reportedly, JACE devices are no longer being installed as it appears Honeywell is transitioning towards a logically flat architecture. There are 143 LONWORKS® controllers and 15 distributed I/O LONWORKS® devices. The distributed I/O LONWORKS® devices are interfaced to Honeywell Excel 500 controllers in a supervisory configuration thus not part of a logically flat LONWORKS® network. In addition, some of the Excel 500 controllers are on C-bus network (not a TP/FT-10 LONWORKS® network). Similarly there are Excel 50 controllers also on a C-bus network. Both the Excel 50 and 500 are configurable to accommodate a TP/FT-10 network connection via a card/slot on the controller. (Information is current as of Mar 07)
- b. Johnson Controls Inc (JCI). JCI has an onsite office that services Bragg and other clients. Through "UMCS II" contract awarded by Huntsville, JCI has installed a number of LONWORKS® systems. Some of the early systems used the proprietary NAE supervisory controller device at the building-level. Later systems reportedly use the JCI flat LONWORKS® architecture and therefore are (should be) in accordance with intent and requirements of UFGS 25 10 10 and 23 09 23. The systems installed by JCI include 33 buildings that use JCI proprietary N2 communications bus and 62 buildings that use

LONWORKS® (presumably TP/FT-10 bus). The first 10 buildings installed under EMCS II contract were N2, the rest used LONWORKS® TP/FT-10. There are two LONWORKS® Control Station (LCS-8520) front-end operator workstation computers and a server, but these workstations are not “on the network” as the JCI system awaits DITSCAP (or equivalent DIACAP) certification. In addition there is no contractual arrangement to obtain system integration services to integrate new (JCI or 3rd party) LONWORKS® building-level systems to the LCS front-end. (Information is current as of Mar 07)

- c. Yamas. Pope Air Force Base (AFB) through a Utility Energy Services Contract (UESC) installed a Yama’s (Tridium/JACE) system including approximately 74 buildings and 126 meters. Pope AFB becomes part of Fort Bragg through Base Realignment and Closure (BRAC) around 2011.
2. In addition to the enterprise-level systems described above, individual building-level DDC systems are procured on a routine basis. The individual multi-vendor systems are often provided with laptops, PCs, and software tools resulting in overwhelming complexity due to the ordinary complexity of DDC technology compounded by multiple tools from multiple manufacturers. For example, Fort Bragg has 14 different DDC system laptops.

The end result is potentially very useful mix of building automation systems that are of limited effectiveness to routine DPW operations in part because the DPW has only limited or no access to the Honeywell and JCI systems. Limitations include access to the operator workstations for the O&M activities and energy manager support functions.

Goals and Benefits

The overall goal is to obtain a basewide BAS consisting of a UMCS (front-end) and local control DDC systems that functions as a single integrated system. The BAS must be manageable and maintainable. It must also be usable by and functional for the Operations Maintenance Division (OMD), the energy manager, and others. Over the long term the BAS must grow with the needs of the DPW and evolve into a fully functional tool that is supportable by and useful to OMD.

The BAS will perform and support the following functions:

- Remote monitoring of buildings. Provide O&M staff and others the capability to easily:

- Display real-time system/equipment performance
- Set up and collect trend data (for example; historical temperature data)
- Set up alarm points including routing of alarms to appropriate personnel while avoiding the creation and generation of nuisance alarms
- Improve service order process especially for HVAC
 - Analyze the problem remotely and send the correct technician
 - Identify the potential problem before arrival onsite
 - EMCS alarms generate service orders, without increasing backlogs
 - Transition from reactive to proactive environment
- Improve customer service by improving response time and situational awareness before arriving on site. Ideally the DPW identifies problems before the customer is aware of situation.
- Improve building occupants comfort level
- Identify problems initially when they are small and cost less to fix instead of complete replacement due to system failure.
- Support energy savings
 - Temperature set backs during nights and weekends including scheduled start-stop of air handling units
 - Monitoring of energy usage and cycling of mechanical and electrical equipment during energy peaks to reduce electrical power demand
 - Improved maintenance and thus performance of equipment
 - Automate other processes such as parking lot and baseball field lighting
- Generate reports.

BAS Characteristics

General Description

The [Fort Bragg] BAS will be based on open systems technology specified in two Unified Facilities Guide Specifications including LONWORKS® technology and ANSI/CEA standard 709.1 communications protocol. One is for building level controls used when a facility is designed and constructed. This is UFGS 23 09 23, Direct Digital Control (DDC) for HVAC and Other Building Systems is for building level controls used when a facility is designed and constructed. The other is UFGS 25 10 10, Utility Monitoring and Control System for a “front end” or a base wide interface to the building level systems. Both of these specifications are intended to specify and procure as open a system as is possible. An open system is one where there is no future dependence on the original installing contractor.

For the purposes of procurement, this means that there is no sole source dependence on any contractor for future system additions, upgrades, or modifications. An open system helps to avoid proprietary sole source procurement in accordance with government procurement rules. In practice, single-source procurement is usually necessary for the UMCS, but can be avoided for the building-level DDC systems. In the case of the UMCS, the procurement of the base wide UMCS can be open competition resulting in a single provider over an extended term. This is discussed under “Path Forward.”

Operator Workstations and Server(s)

There will be multiple operator workstations (OWS) for: OMD chief, OMD shop supervisor, OMD work leaders, OMD common area for use by OMD staff, Energy Manager, and DPW Director with several levels of password access to the various features. A web-based Graphical User Interface (GUI) will be considered. Workstations will display information and graphics as specified in UFGS 25 10 10 including floor plans (except for sensitive areas such as SKIFs)

LDPs

There will be a local display panel (LDP) mounted on or in each enclosure located in a mechanical room. LDPs can permit both display and adjustment of certain control system parameters such as control inputs, outputs, and setpoints. The UFGS 23 09 23 guide specification calls for the designer to decide and thus specify if LDPs will permit display, adjustment, or both display and adjustment of parameters. This decision should be made based on maintenance staff input. Specifying the functionality is accomplished by showing the required functions in a Points Schedule drawing where this drawing is referenced in UFGS 23 09 23. This, along with other designer options contained in the UFGS 23 09 23 specification should be reviewed by the DPW so that the DPW and particularly the maintenance staff have an opportunity to provide input to system design and specification. These preferences should be documented in the IDG.

IT network

The BAS will use the existing high speed basewide IT network for communication between building-level DDC systems and the UMCS workstations. All applicable hardware and software will have DOIM/DITSCAP (DIACAP) approval/certification. Wireless technology will be considered

where the existing IT infrastructure is not suitable (for example, due to cost). Wireless communication could drastically reduce some of the capital cost, but it currently is not approved at the Army installation level. There are a lot of hurdles. Wireless is not currently authorized to access the domain and will need DITSCAP Interim Authority To Operate (IATO) approval. The installation does not have the backbone communication infrastructure to support wireless transmission especially for WiMax.

Building Control Network

All project will include a TP/FT-10 building control network and all DDC devices will be connected to this network. Building-level designs will show the proposed location of the Building Point of Connection (BPOC) (to be installed by the System Integrator) and the TP/FT-10 network cabling (installed by the building-level contractor) will extend to that location. The BPOC (CEA 852 router) locations shall not be in communication closets. They may be in electrical closets or in approved mechanical rooms in approved and appropriate enclosures.

Laptops with NCT

The primary O&M tool will be a laptop with a network configuration tool (NCT) software. Five individuals within OMD will possess NCT laptops.

Software

Other software packages provided by Contractors (such as programming software) will reside with the system integrator (and one OMD POC). Programming software should only be needed to initially program “programmable” controllers (by the installing Contractor). All programmable controller settings necessary for O&M activities will be exposed as LONWORKS® SNVTs or Configuration Property Types (CPTs) and thus accessible using the NCT or OWS.

Controllers

Controllers come in two basic varieties: programmable and application specific. Programmable controllers will be avoided. Complex applications may require them, but as a rule application specific controllers (ASCs) will be given preference. Contractors will be encouraged to use ASCs due to their relative simplicity. Programmable controllers with plug-ins will be given preference over those without plug-ins. Note a plug-in is a software tool that can be launched from the NCT and can be used to remotely re-

program a programmable controller). ASCs will be provided with plug-ins as specified in UFGS 23 09 23. This requirement must be enforced by the USACE Construction office.

Miscellaneous

Controls and equipment must be maintenance accessible. Equipment must be appropriate. The Workgroup will generate a list of requirements and pursue incorporating these requirements into the IDG.

Control Devices and Interfaces

- Pneumatic actuation of valves and dampers is preferred over electric actuators due primarily to reliability and simplicity. Positive positioners should be avoided unless deemed necessary for the application (for example, due to the need for moving large volumes of air or for device sequencing).
- Filter alarms. Differential pressure switches used to sense loaded (dirty) air filters are problematic (for a variety of reasons). The current preference is to not use these, but instead generate a time-based low-priority alarm (perhaps via e-mail) where, for example, after 3 months an alarm is generated to notify OMD that a particular filter is due to be changed.
- Fan coil unit condensate drain overflow switch monitoring and alarm.

Additional preferences may/will be added as they are identified.

UMCS Management

The UMCS will be managed by the System Integrator (SI) and by the UMCS Workgroup (or their designated in-house individual) and with clear distinction of roles and responsibilities. The Workgroup will define SI roles and responsibilities and will identify a mechanism to obtain these long term services. In summary, the SI will review DDC submittals, manage DDC Contractor submittals (Points Schedules, LNS plug-ins, LNS databases, XIF files), integrate new/renovated DDC systems into the BAS, maintain the LNS database, update the Graphical User Interface (GUI) for added buildings, manage the overall maintenance of the UMCS (software updates, etc.), coordinate all networking activities with DOIM, and manage and maintain laptop hardware and software.

Systems Integration and Support

A system integrator (SI) will be perform systems integration and UMCS management services as defined above under UMCS Management. In addition, the SI will provide support services potentially including embedding technical staff with OMD to provide operation and maintenance support and on the job training. SI requirements need to be further defined as described under Path Forward.

Support Structure

Successful design, specification, procurement, operation, maintenance, and expansion of the [Fort Bragg] BAS includes the following support structure:

- *UMCS Workgroup*. Defines and executes the Implementation Plan. Holds periodic meetings to assess progress, make changes to the plan as necessary, and provides general oversight and management of the BAS.
- *System Integrator*. Performs UMCS management and integration services.
- *Directorate of Public Works (DPW) Engineering Design*. Will work with the Workgroup to define BAS specifications for in-house designs. These specifications must be tailored to the specific contracting mechanism where these mechanisms include: [Job Order Contract,]
- *Directorate of Contracting*. May be needed to help identify a contracting vehicle to obtain the initial UMCS and the long term services of a Systems Integrator (SI).
- *Directorate of Information Management (DOIM)*. Will work with the Workgroup and the Huntsville Contractor to identify DOIM requirements. This will result in pertinent requirements to be included in BAS project specifications along with an agreement between DOIM and the Workgroup on methods and procedures to be followed.
- *DPW Master Planning Office*. Will work with the Workgroup to ensure that the Installation Design Guide (IDG) reflects requirements for the BAS.
- *DPW Maintenance Staff*. Provides input to Workgroup. Reviews the Implementation Plan. Designated OMD staff will be trained as DDC Specialists. The training will include basic laptop usage, NCT software, LNS-plugin-ins, DDC system acceptance procedures. All OMD HVAC O&M staff will be trained on basic PC usage and fundamental usage of the centrally located OWS (how to pull up and view points and alarms).

- *USACE District Office Engineering Design.* Ensures that designs for new facilities and renovations of building control systems are consistent with the Implementation Plan. Reviews the Implementation Plan.
- *USACE Construction Office.* Works with Workgroup to develop a Building Acceptance methodology. Reviews the Implementation Plan.

Path Forward

Plan Documentation

The UMCS Workgroup will review and refine the Implementation Plan. The plan will be a living document and coordinated with other interested and involved parties including those listed under the Support Structure. The UMCS workgroup reviewed the initial draft Plan on 27 February 2007.

Select UMCS

Fort Bragg needs to select/procure a basewide single-vendor UMCS to serve as the front-end (brain) for all their BAS systems. This is a three step process.

1. **Define/Specify UMCS.** The UMCS Workgroup must edit the UMCS requirements in the generic “UMCS and Systems Integrator RFP/SOW” contained in the “IMCOM LONWORKS® Building Automation Systems Implementation Plan” and edit UFGS 25 10 10 to include [Fort Bragg] specific requirements. In doing so the Workgroup needs to make sure the RFP/SOW and UFGS 25 10 10 include [Fort Bragg’s] desired UMCS requirements, features, functions, and capabilities, particularly those listed in Goals and BAS Description portions of this (Fort Bragg’s) Implementation Plan. The Workgroup will need to coordinate with and include [Fort Bragg] DOIM/IT related UMCS requirements (need for IP network drops, providing static IP addresses, etc.).
2. **Define/Specify System Integration Services and Support Services.** (This can be considered integral to the above step). The UMCS Workgroup must edit the UMCS requirements in the generic “UMCS and Systems Integrator RFP/SOW” contained in the “IMCOM LONWORKS® Building Automation Systems Implementation Plan” and edit UFGS 25 10 10 to include [Fort Bragg] specific requirements. The UMCS Workgroup must identify SI services/requirements and related support services.
3. **Procure UMCS and SI Services.** The UMCS Workgroup must identify an approach to procure the single vendor basewide UMCS along with SI services. In the case of SI services, one option is to award an SI contract independent of the UMCS contract where the SI contract is for a

long term such as 5 years where a single entity performs all SI services as new buildings/control system are installed/constructed. Another option is to include SI services requirements in each new building-level DDC system contract where each building-level Contractor is responsible for system integration (where the Contractor may choose to do the SI him/herself or may hire whomever installed the UMCS).

Some notable and miscellaneous issues/tasks related to the above steps include:

- Make sure that the items listed in the Goals and BAS Description portions of this Plan are incorporated into contract documents.
- Develop LONWORKS® Points Schedules. Identify and show mandatory and optional SNVT-related points. Include chillers and boilers. Consider standard SNVT naming convention. Consider standard sequence of control. CERL will take the lead on this.
- Identify arrangement for potentially embedding SI maintenance staff with OMD.
- NCT update methodology. Automatic versus manual updates of LNS database.
- O&M tool options such as PDA or portable LDP with TP/FT-10 dongle.
- Require SI to monitor building usage and ratchet down when troops are deployed.
- Division of responsibility between the UMCS/DDC/SI contractors and DPW/OMD
- Compare requirements to Fort Hood contractual arrangement.
- All PCs may be transitioning to dumb terminals. What is the impact?

Integrate Existing LONWORKS® Buildings

The UMCS Workgroup will consider the need and technical potential for connecting existing LONWORKS® buildings into the BAS (non- LONWORKS® buildings are a lower priority and will be considered by the Workgroup at a later date on a case-by-case basis). To this end, the UMCS Workgroup will assist in the execution of a Contract being awarded by Savannah District (SAS) to obtain external assistance where the contractor will survey existing BAS elements to identify existing LONWORKS® controls and local control contractor support capabilities as part of identifying implementation requirements/approach. As part of this, the UMCS Workgroup will identify buildings to be surveyed on a priority basis where mini-plants will have high priority as will new buildings and those with a large footprint. The SAS contractor will assess the potential and cost for pulling local con-

trol system(s) into the basewide UMCS. A rough estimate is about \$2000 to provide and install a CEA-852 router under the assumption that the IP network is available, the TP/FT-10 building control network exists and does not need to be extended, and the building control system contains LNS compatible devices including LNS-plug-ins and a current LNS database. The Contractor will develop SOW requirements to perform the integrations.

Savannah District Coordination

The UMCS Workgroup will coordinate with Savannah District on design and specification requirements for future OMA and MILCON projects connecting into the installation wide building automation system (BAS). One issue is that current and future MILCON does not support running fiber to the mechanical rooms or connecting to existing installation systems. The installation has smart buildings that do not have any place to send their data.

IDG Update

The UMCS Workgroup will incorporate BAS requirements into the Installation Design Guide (IDG). Of particular interest is the UFGS 23 09 23 guide specification, which contains various designer options/selections that will impact features and functions of installed DDC systems. These options should be reviewed by the DPW so that the DPW and particularly the maintenance staff have an opportunity to provide input to system design and specification. These preferences should be documented in the IDG. Many of these UFGS 23 09 23 options/selections are specified by showing the required functions in a Points Schedule drawing where this drawing is referenced in UFGS 23 09 23. The IDG might include these drawings.

On Site Seminar

The UMCS Workgroup will assist with and participate in an on-site training and coordination seminar conducted by ERDC-CERL, SAS, and HNC to help further define the Implementation Plan.

UMCS and DDC Training

The UMCS Workgroup will identify training needs and a strategy for obtaining needed training such as including Fort Bragg specific training re-

quirements in construction contracts and in the UMCS/SI RFP/SOW described under “Select UMCS.”

BAS/DDC System Acceptance Methodology

The UMCS Workgroup will define a BAS building-level DDC system acceptance methodology checklist/procedures. The acceptance process will include design review by DPW/OMD along with procedures for construction inspectors and DPW to help ensure that all construction projects comply with the requirements of the BAS.

Energy Conservation Investment Program (ECIP) and Other Funded Support

The UMCS Workgroup will identify and seek funding support for the Fort Bragg BAS. This includes developing an FY09 ECIP proposal in support of the basewide BAS.

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14. ABSTRACT Army Installations often expand their use of digital control systems for heating, ventilating, and air conditioning and other mechanical and electrical building systems on a building-by-building basis. The control systems are installed under separate contracts by different contractors resulting in intra-system incompatibilities. The implementation of multi-vendor Open Building Automation Systems (BASs) is meant to overcome such incompatibilities; however BASs can present their own technical and administrative (including contractual) challenges. This interim report defines a methodology for the development and execution of a basewide Open BAS implementation plan based on LonWorks® technology and American National Standards Institute (ANSI) communications standard 709.1 where the BAS consists of a basewide Utility Monitoring and Control System (UMCS) that is interoperable with multi-vendor LonWorks® direct digital control (DDC) systems.					
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